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Household-Level Determinants of Adoption Speed of Soil Fertility Boosting Technology: A Duration Analysis Approach of Composting adoption (A Case Study of Toke Kutaye District, West Shawa, Oromiya)

By:

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Statement of Declaration

This is to declare that this thesis work entitled **“Household-Level Determinants of adoption of speed of soil fertility Boosting Technology: A Duration Analysis Approach of Composting Adoption (A case study of Toke-Kutaye District ,West Shawa ,Oromiya”** submitted in Partial Fulfillment of the Requirements for the award of the degree of MSc. in Economics (Development Policy Analysis) to the College of Business and Economics, Mekelle University, through the Department of Economics is my is an authentic work carried out by me. All sources of materials used for this thesis have been duly acknowledged.

Name of the student: Robera Merga

Signature: ______________ Date:_____________

CERTIFICATION

This is to certify that this thesis "**Household-Level Determinants of adoption of speed of soil fertility Boosting Technology: A Duration Analysis Approach of Composting Adoption (A case study of Toke-Kutaye District, West Shawa, Oromiya** "submitted in Partial Fulfillment of the Requirements for the award of the degree of MSc. in Economics (Development Policy Analysis) to the College of Business and Economics, Mekelle University, through the Department of Economics, done by **Robera Merga Bulti**(ID No CBE/PR 105/04) is an authentic work carried out by under my guidance. To the best of our knowledge the matter embodied in this thesis work has not been submitted earlier for award of any degree or diploma.

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Biographical Sketch of the Author

The author was born in West shawa zone, Toke Kutaye district at a specific place called Dada Galan (About 120 km West of Finfinne) in September 1986. He attended Elementary School education at Dale Dawe primary school and then completed his secondary school education at Guder Senior Secondary School (in Oromiya). Then, he joined Ambo comprehensive senior secondary school for attending a preparatory level program in September, 2004.After that he joined Mekelle University in September, 2006 and graduated with a BA degree in Economics in 18 July, 2009.

Following his graduation he employed in Arba Minch University and served as an instructor in the Department of Economics from September, 2009until he joined again Mekelle University to pursue his Master of Science degree in Economics with specialization in Development policy Analysis in September, 2011.

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Acronyms

AEASA	Agricultural Economists Association of South Africa
CADU	Chilalo Agricultural Development Unit
CIMMYT	International Wheat and Maize Improvement Center
CPHM	Cox Proportional Hazard Model
CSA	Central Statistics Authority
DAs	Development Agents
EDRI	Ethiopian Development Research Institute
EEPFE	Environmental Economics Policy Forum of Ethiopia
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
n.d	year not given
PAs	Peasant Associations
WUR	Wageningen University and Research Center

Abstract

Most of the studies previously conducted on technology adoption have employed cross-sectional data to analyze why some farmers adopt at a certain point in time though the static approach does not consider the dynamic environment in which the adoption decision is made and does not incorporate the speed of adoption of a certain technology. Using primary data from a survey of random sample of 200 smallholder farm households in Toke kutaye district of west shawa Zone, Oromiya, this study investigated determinants of adoption speed of compost using Duration analysis (Cox proportional Hazard Model) approach. Results revealed that while education level of the household head, livestock ownership, index of awareness, more availability of active family labor, farm size, tenure security and water accessibility in nearby location accelerated the adoption compost, age of household head, farm plot at distant location from residential area and perception towards health side of compost retarded the adoption speed of compost. To accelerate adoption of the technology requires policies that promote farmers' educational level programs, high access to extension services, field demonstration on compost, frequent trainings about compost, eroding the bad perception they have for compost, targeting young farmers for intervention.

Key words: speed of Adoption, duration analysis (Cox proportional Hazard model), Compost, Toke kutaye

Chapter One

Introduction

1.1. Background of the study

"The need to meet ever increasing nutrition demands of the expanding human populations makes sustainable agriculture and agro-based sectors a front burner environmental and social development issue in sub-Saharan Africa"(Omotayo and Chukwuka,2009). In these countries the unsustainable land cultivation practices such as inadequate replacement of soil nutrients taken up by crop have led to accelerated depletion of the natural soil base available for food production for the ever growing population (Hossner and Juo, 1999), and therefore soil productivity maintenance remains a key environmental concern in countries of sub-Saharan Africa (Oyetunji et. al., 2001).

Ethiopia is one of the sub-Saharan African countries where depletion of the soil resources is becoming a critical problem and is a major cause of low and in many places declining agricultural productivity, continuing food insecurity and rural poverty in Ethiopia (IFPRI et.al., 2005).The annual rate of soil loss in the country is higher than the annual rate of soil formation rate. As a result of soil erosion the country losses over 1.5 billion tons of topsoil from the highlands each year, which could have added about 1.5 million tons of grain to the country's harvest (Lulseged and Paul, 2008).Studies indicate that the national average yields of major crops for smallholder sector is less than 1.2 metric ton per hectare (CSA, 1991). These yields are among the lowest in the world and indicate the low productivity of the agricultural sector (Assefa, 1995 and Dadi et.al., 2004). According to Bekele and Holden (1998), this daunting performance of the agricultural sector in the country is emanated from many factors of which the low use of agricultural technology that enhances yield is one. Their finding pointed out that resource degradation particularly soil degradation in the form of nutrient depletion is an important cause for the decline in the country's agricultural production. The whole findings indicate that soil nutrient depletion is a very serious threat to food security of people and requires urgent management interventions.

Faced with the danger that soil degradation would undermine efforts to increase agricultural productivity on a sustainable basis has led the Ethiopian government to take preventive action and investment in soil conservation and rehabilitation in the country (Abebaw et.al.2011). The '*Forty-Day-Campaign*' of the rural community mobilization since 2012 throughout the country is a good evidence for the government's commitment to reduce soil erosion and soil nutrient depletion in the country. Besides upgrading the traditional methods of soil conservation and rehabilitation, the government and other NGOs are exerting their maximum effort in restoring the fertility of soil by modern innovative agricultural technologies.

The use of new technology in agricultural sector seems to be a precondition for increasing productivity as well as for shifting from subsistence farming to end poverty. This transformation encourages the adoption of more advanced technologies such as organic fertilizer (Thapa, n.d).

Boosting agricultural growth through the introduction of modern agricultural technologies remains one of the most urgent goals facing policy makers in Ethiopia in general and in the study area in particular, where the increase in rural human population causes high potential land less available and extends farming into more fragile lands which is previously unsuitable for cultivation.

1.2. Statement of the Problem

In the study area many smallholder farmers are increasingly under pressure to intensify their land use due to the fact that population growth reduced fallow periods which further led to low fertility regeneration and soil degradation. With increasing population on the existing farm land, the pressure on agriculture to provide food and livelihoods is also equally increasing. Given the ever growing population in the region and the decreasing possibilities to increase or change the cultivated area, standard recommendations across the country in general and in the study area in particular are to maintain the productivity of the land through regeneration of soil fertility using innovative agricultural technologies.

Besides the decreasing of high potential land for farming the current escalation price of inorganic fertilizer (which is taken as a natural complementary option that received the attention of agriculturists in an effort to boost soil productivity) has been questioning the farmers and creating a pull back from utilizing it which in turn has a negative implication for short-term soil fertility enhancement. This reduction in soil fertility enhancement through synthetic fertilizer will have its own negative consequence on boosting their farm productivity and hence on ensuring food security in the country as well.

The awareness of this problem and the growing concerns relating to land degradation, threat to eco-systems from over and inappropriate use of synthetic fertilizers, atmospheric pollution, soil health, and soil biodiversity have rekindled the interest of the country in to organic recycling practices (Tadesse and Abdissa, 1996).“No doubt by using agricultural chemicals such as fertilizer we solved our short term goal, but left a dangerous legacy for future generations. The soil became poisoned and the plants that grew in it were weak, low yielding and prone to disease. Marginal farmers are despairing at successive crop failure”. This was an article written by Siddinqsons Agro and Food (n.d) on the negative side effects of chemical fertilizer which was another pushing factor for the recent invention and adoption of organic recycling practices.

One of such organic recycling practices recommended by experts and found to be relatively cost-effective for farmers, environmentally amenable, and have relatively long term effect on soil fertility is compost technology (Getnet, 2008).

Despite considerable efforts made towards this technology adoption as a viable low cost alternative in restoring soil fertility, the speed of adoption by farmers remains slow and the achievements made so far are below expectations, and soil fertility continues to decline in the area. In addition to slow adoption rates, there is a pull- back from adopting the technology.

The limited success of the efforts highlights the need to better understand the factors that accelerate/decelerate the adoption of the technology**.** It is the aim of this study to explore why this soil fertility improving technology recommended by experts is not widely adopted by the farmers. Are there any socio-economic factors that inhibit and constrain their adoption at the household level? Among the group of adopters themselves why some farmers adopt the technology sooner and others later?

To the best of the researcher’s knowledge there have been no previous studies analyzing the timing of adoption or the effect of factors on the duration farmers waited before they first adopted this technology, and this study would ,therefore, be the first attempt to be conducted in the district to find out the answers to these questions through empirical study.

1.3. Objectives of the study

The study intended to explore why some farmers adopt composting sooner while others adopt it later, and still others remain resistant in Toke kutaye district. Specifically, it focused on achieving the following objectives:

- To investigate the factors affecting farmers' decisions to adopt composting in the study area.
- To explore factors determining the speed of adoption of compost in the district.
- To draw policy recommendations that might be helpful in the design and implementation of the technology in the near future.

1.4. Scope of the study

The study is conducted in Toke Kutaye district of west shawa zone on investigating the determinants of adoption speed of compost. The study focuses only on the rate of adoption, not on the intensity of adoption, using duration analysis approach. In the analysis the baseline time is taken to be the year 2008 when the technology introduced in to the district. Therefore, the waiting time before adoption is computed starting from this baseline year.

1.5. Significance of the study

There are various determinants that positively or negatively contribute towards adoption speed of the compost technology. Identification of these determinants are crucial for policy makers, researchers and organizations involved in soil conservation and regeneration development programs to get enough information on the adoption speed of compost which in turn would help them to suitably modify their strategies. Hence, the study would contribute much in generating appropriate information on determinants of adoption speed of compost technology. Moreover, the research recommendations can be applied in other areas having similar socio-economic characteristics in the region.

1.6. Organization of the thesis

The thesis is organized into five chapters. It starts with the introduction which includes statement of the problem, objectives of the study, significance of the study, scope and limitation of the study and methodology including sampling techniques, methods of data collection and tools for data analysis. The second chapter reviews literature that deals with past studies and information pertinent to the study. The third chapter presented a methodological approach of the study. In the fourth chapter the main findings of the study are discussed. Finally, conclusions and policy implications are provided in chapter five.

Chapter Two

Review of Literature on Technology Adoption

2.1. Introduction

This chapter gives theoretical and empirical highlights for the study. It is organized into sub-topics such as definition and basic concepts of adoption, adoption speed and its determinants, categories of adopters, adoption stage, empirical studies of technology adoption in Ethiopia and elsewhere, and Current status and research gaps in technology adoption in Ethiopia.

2.2. Definition and concepts of Technology adoption

The term "technology" has been defined by different scholars in a variety of ways. For instance, Bonabana, J., (2002) has used 'technology' and 'innovation' interchangeably (cited in Rogers, 1995).According to him, technology is the design for instrumental action that decreases the uncertainty in the cause-effect relationship involved in achieving a desired result (Bonabana, J., 2002).Enos and Park (1988), on the other hand, defined the word 'technology' as "*the general knowledge or information that permits some tasks to be accomplished, some service rendered, or some products manufactured*". Others like Abara and Singh (1993) understood it as the actual application of a certain accumulated knowledge.

Similarly, adoption is defined by different authors in a different fashion. "*Adoption commonly refers to the decision to use a new technology or practice by economic units on a regular basis*" (Hailu Beyene, 2008). "*Adoption is an outcome of a decision to accept a given innovation*"(Bonabana, J., 2002).Rogers (1983) defined 'adoption' as use or non- use of a new technology by a farmer at a given period of time. Feder, Just and Zilberman (1985) while quoting Roger's earlier work of 1962 defined the word adoption as "a mental process an individual passes from first hearing about an innovation to final utilization"**.** Furthermore, they identified individual adoption (farm level) from aggregate adoption. According to them individual (farm level) adoption refers to the farmer's decisions to integrate new technology into their production process whereas aggregate adoption (also called diffusion of a technology) was defined as the process of spread out of a new technology within the whole region or population implying aggregate level of use of a given technology within a given geographical area as measured by aggregate adoption (Hailu Beyene, 2008). The study of composting adoption is referring to the first type of adoption-the individual adoption.

Some still opted to conceptualize the concept of adoption in terms of its *rate of adoption and intensity of adoption*. One should differentiate them clearly before dealing with the concept of adoption. Bonabana, J., (2002) put this definition as follows:

> *Much scholarly interest on adoption falls in two categories: rate of adoption, and intensity of adoption. It is usually necessary to distinguish between these two concepts as they often have different policy implications. Rate of adoption, the relative speed with which farmers adopt an innovation, has as one of its pillars, the element of 'time'. On the other hand, intensity of adoption refers to the level of use of a given technology in any time period (Bonabana, J., 2002).*

In case of this study (the study of composting adoption), the researcher uses the former concept of adoption-*rate of adoption*, not intensity of adoption.

2.3. Speed of technology adoption and its determinants

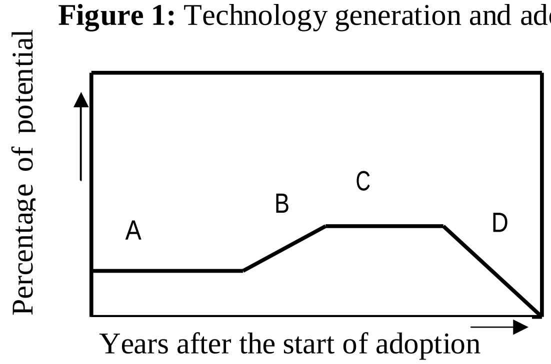
The speed of adoption is usually measured by the **length of time** required for a certain percentage of members of a system to adopt a given technology (Bonabana, J., 2002). It has been argued that potential adopters' perceptions of the attributes of the new technology affect the rate with which that technology is adopted by an individual (Hailu Beyene, 2008). Rogers (1983), for instance, identified five characteristics of technology that can influence the rate of adoption: relative advantage, compatibility, complexity, divisibility, and observability. Supe (1983) added two more attributes that affect the rate of adoption: variations in the cost of adoption and group action requirements of the technology. According to him technologies which require group actions for adoption(eg, drainage and watershed management) are adopted slowly compared to technologies that are taken up entirely on individual basis (eg fertilizer).

Of the technological characteristics mentioned above, relative advantage is regarded as the one with the strongest effect on the rate of adoption. The relative advantage can be subdivided into economic and non-economic categories. The economic categories are related to the profitability of the technology while the non-economic features are a function of variables including saving of time (leisure) and increase in comfort (Ratz, 1995). The higher the relative advantages, other things remaining constant, the higher the rates of adoption. The compatibility of a technology indicates the degree to which that technology is consistent with the existing social values, cultural norms, experiences and needs of the potential adopters. This attribute also plays a key role in influencing the speed of adoption.

A study by Byerlee and Hesse de Polanco (1986) examined the relationship between speed of adoption of technologies and various economic factors. Their study showed that the adoption pattern of a particular technology is a function of five characteristics (profitability, riskiness, divisibility or initial capital requirement, complexity, and availability).Their study further indicated that profitability and riskiness of a given technology are a function of agro-climatic and socio-economic environments, such as rainfall and prices. In other words, rainfall and prices indirectly influence the rate of adoption. Interactions between technologies will also affect the rate of adoption. The benefits of using improved seed (hybrid),for instance, are enhanced by fertilizer application especially under favorable environmental conditions in high potential areas measured by rainfall potential, soil fertility and other agro-ecological factors, such as altitude, etc(Feder, 1982; Byerlee and Hesse de Polanco, 1986; Hassen et al., 1998).

The speed of improved technology adoption depends on the availability of improved technologies, which involve the generation and dissemination of these technologies to users (in this case to farmers).Generation of improved technologies is a time-intensive process leading to a depreciation of the technologies. More time is also required for adoption to take place i.e. the time that passed from the introduction of the technology until the decision is made to use it. Figure 1 depicts the time taken to generate and disseminate improved technology and the adoption process. A generic adoption profile includes the technology development lag ending with a release of new technology (**A)** and the initially increasing adoption rate, which reflects the growing number of farmers in the target area who are using the technology **(B).**An adoption plateau occurs when most target farmers have been exposed to the technology and have decided whether or not to adopt it **(C).** Adoption then declines as the technology becomes obsolete **(D).** Together, these components determine the speed with which adoption of yield increasing technologies has impacts on farmers' production (Mills et al., 1998).

Figure 1: Technology generation and adoption profile



All potential adopters of a new technology do not adopt it at the same time. Thus, when dealing with the concept of adoption it is necessary to identify the type of adopters one is dealing with (i.e. Classification of individual households according to their readiness to use the technology) and even the adoption stages. The next sub-topic discusses these two points.

2.4. Categories of adopters and stages of adoption

In their adoption studies (Mosher, 1979; Rogers, 1983), they identified and described five categories of adopters in a social system (see figure 2). These categories were as follows:-

1.**Innovators** (the first users of a technology):-Innovators are the first individuals to adopt an innovation. This category of adopters are characterized by willingness to take risks, youngest in age, highest social class, great financial lucidity, very social and closest contact to scientific sources and interaction with other innovators. Risk tolerance they have made them adopt technologies which may ultimately fail. Financial resources they have help them in absorbing any failures they might face.

2. **Early adopters** (who enjoy leadership, prestige, and who tend to be opinion leaders):-This is the second fastest category of individuals who adopt an innovation. These individuals have the highest degree of opinion leadership among the other adopter categories. Early adopters are typically younger in age, have a higher social status, have more financial lucidity, advanced education, and are more socially forward than late adopters. They are more discrete in adoption choices than innovators.

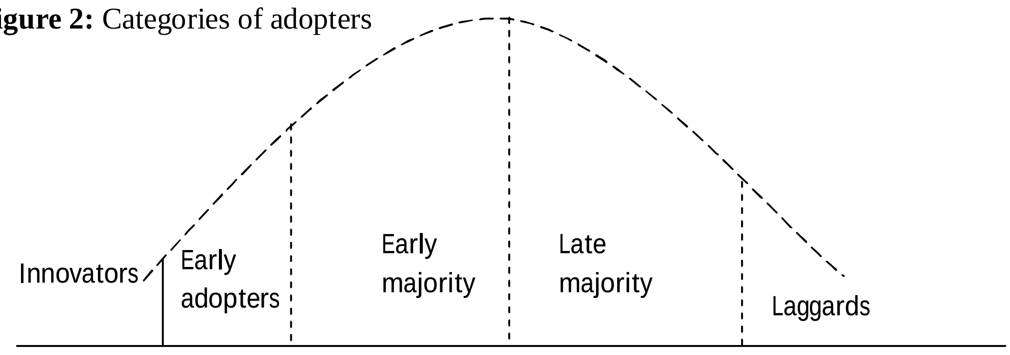
3.**Early majority** (the first part of the mass to adopt the technology):-Individuals in this category adopt an innovation after a varying degree of time. This time of adoption is significantly longer than the innovators and early adopters. Early Majority tend to be slower in the adoption process, have above average social status, contact with early adopters, and seldom hold positions of opinion leadership in a system.

4. **Late majority: -**Individuals in this category will adopt an innovation after the average member of the society. These individuals approach an innovation with a high degree of skepticism and after the majority of society has adopted the innovation. This category of adopters is typically skeptical about an innovation, have below average social status, very little financial lucidity, in contact with others in late majority and early majority, very little opinion leadership.

5. **Laggards**:-Individuals in this category are the last to adopt an innovation. Unlike some of the previous categories, individuals in this category show little to no opinion leadership. These individuals typically have an aversion to change agents and tend to be advanced in age. Laggards typically tend to be focused on "traditions", likely to have lowest social status, lowest financial fluidity, be oldest of all other adopters, in contact with only family and close friends, very little to no opinion leadership.

Rogers(1983) indicated that the majority of early adopters are expected to be younger, more educated, venturesome, and willing to take risk. In contrary to this group, the late adopters are expected to be older, less educated, conservative, and not willing to take risks. However, a study by Runquist(1984) noted that the practical aspect of the classification of adopters into five categories, as Rogers(1983) did, is relevant to deliberate or planned introduction of innovation. The usefulness of this categorization is restricted as there isevidence indicatinga movement from one category to the other, depending on the technology introduced.

Figure 2: Categories of adopters



Regarding the stages of adoption, considerable efforts were made to identify the various stages of the adoption decision process. Studies by Rogers and Shoemaker (1971) and Rogers (1983) described the innovation adoption decision process, as the mental process from the first knowledge of an innovation to the decision to adopt or reject. The study further indicated that the innovation adoption decision process is different from the diffusion process. The former (i.e adoption) takes place within the mind of an individual while the latter (i.e diffusion) occurs among the units in a social system or within a region. Based on this theoretical background the study identified five stages in the adoption process.

1.**Awareness the initial knowledge of the innovation**: **-** In this stage the individual is first exposed to an innovation but lacks information about the innovation. During this stage of the process the individual has not been inspired to find more information about the innovation.

2. **Interest and persuasion**: **-** In this stage the individual is interested in the innovation and actively seeks information/detail about the innovation.

3. **Evaluatio**n: **-** It was in this stage that individuals take the concept of the innovation and weigh the advantages/ disadvantages of using the innovation and decide whether to adopt or reject the innovation. Due to the individualistic nature of this stage, Rogers noted that it is the most difficult stage to acquire empirical evidence (Rogers, 1964).

4. **Trial and confirmation**: **-** In this stage the individual employs the innovation to a varying degree depending on the situation. During this stage the individual determines the usefulness of the innovation and may search for further information about it. In this stage the individuals finalizes their decision to continue using the innovation.

5. Adoption:- These stages in the diffusion process imply a time lag between awareness and adoption. It is usually measured from first knowledge until the decision is made whether to adopt or not.

What one can understand from these stages is that adoption is not a random behaviour, but is the result of sequence of events passing through these adoption stages (Rogers, 1983).This can lead us to models dealing with adoption decision of a certain technology.

2.5. Models explaining technology adoption

In answering the question of what determines whether a particular technology is adopted or not most of the adoption of agricultural innovation studies used static rather than dynamic models (Hailu Beyene,2008).

2.5.1. Static adoption models

A static model refers to farmers' decisions to adopt an improved technology at a specific place and a specific period of time. This model attempted to answer the question of what determines whether a particular technology is adopted or not and what determines the pattern of adoption at a particular point in time. The results of these studies have generally remained mixed regarding the importance and direction of influence of certain variables (Ghadim and Pannell, 1999). Moreover, the static model fails to capture the timing of adoption (i.e. when is the right moment to adopt). The approach focuses at a single point in time and tries to identify who is using the technology and who is not. But, technology adoption is a dynamic process as indicated above. This means early adopters differ from later adopters and current non-adopters may eventually adopt the technology in the future. The static approach, therefore, fails to consider the speed of adoption and the effect of time-dependent elements in elucidating adoption (Butler, J.S. and Moser, C., 2010).

The other limitation of the static approach is its inability to control for farmer heterogeneity even when panel data is available (Butler, J.S. and Moser, C., 2010). Since we would lose some of our time-varying information in this approach, we would not be able to control for unobserved heterogeneity.

Regardless of these major drawbacks of the static model, most of adoption studies continue to apply variants of the static binary setting of logit or probit models (Janson, 1992; Shields et al., 1993; Polson and Spencer, 1991). In these models the adoption decision is merely dichotomous (whether or not to adopt) where a functional relationship between the probability of adoption and a set of explanatory variables is estimated econometrically using logistic distribution for the Logit procedures and the normal distribution for the Probit procedures. The Logit/Probit methods investigate the effects of regressors on the choice to use or not use (Feder et al., 1985). For instance, if a Probit model is used to analyze data on fertilizer adoption, a farmer who adopts the recommended level of fertilizer is treated the same as a farmer who applies one tenth of the recommendation (Ghosh, 1991). But the alternative static econometric procedures such as the Tobit (Tobin, 1958) are used to analyze quantitative adoption decisions when information on the intensity of adoption is available (e.g., data on percentage of area planted to improved varieties, amount of fertilizer/herbicide applied, etc.).

However, in working with continuously measured dependent variables such as quantity or area, some of the data points will have a zero value (i.e., for non-users). In this case the dependent variable is censored where information is missing for some range of the sample. If information on the dependent variable is available only if the independent variable is observable, the dependent variable is described as truncated (Kennedy, 1992). The Tobit model provides coefficients that can be further disaggregated to determine the effect of a change in the i^{th} variable on changes in the probability of adopting the new technology and the expected intensity of use of the technology.

However, a study by Dong and Saha (1998) indicated that a Tobit model imposes restrictions that the variables and coefficients determining whether and how much to adopt decisions are identical. These weaknesses are addressed in dynamic adoption models (Hailu Beyene, 2008).

2.5.2.Dynamic adoption models

Dynamic adoption models are model that allow for changes in farmers' adoption decisions as farmers gain skills in a technology from year to year.

Duration models have several advantages over static models dealing with adoption decision. First, they take advantage of more information, meaning the timing of adoption, which cannot be exploited in logit or probit models. Thus, they allow continuous-time analysis regardless of the periods used in the data themselves. This means that in these model spredicted probabilities can be obtained over a period of one year regardless of the number of periods observed.

Second, they also take into account the evolution of the adoption of the technology and its determinants over time.

Third, duration analysis techniques are appropriate to account for right censoring (when we only know that the farmer did not adopt the technology at least up to a given period t), and easily handle time-varying covariates (Poolsawas, S. and Napasintuwong, O.A., 2012). These "*right-censored observations contribute to the hazard rate with their survival information*" (Coetzee C., 2006).

Fourth and the last, duration models can be used to control for unmeasured heterogeneity (Deaton, 1997; Butler, J.S. and Moser, C., 2010).A further advantage of duration model is the ability to control for unmeasured heterogeneity without the need for a full panel data set.

Recently, this model has been getting growing concern and applied in a number of agricultural economics studies to capture the dynamic aspects of technology adoption. Few of these studies are given in the following paragraph.

Fuglie and Kascak (2001) estimated the long-term trends in adoption and diffusion of conservation tillage by U.S. farmers; Burton et.al. (2003) explored the determinants of adoption of organic horticultural in the UK; Dadi et.al. (2004) estimated the impact of variables on the timing of agricultural technology adoption by smallholders in Ethiopia; Abdulai and Huffman (2005) explained the diffusion and farmer's adoption of crossbred-cow technologies in Tanzania; D'Emden et al. (2006) investigated significant variables on the soil-conserving adoption by grain farmers in Australia; Matuschke and Qaim (2008) studied the dynamics of hybrid pearl millet adoption in India; Hailu Beyene (2008) studied on Adoption of improved Tef and wheat production technologies in crop-livestock mixed systems in northern and western Shewa zones of Ethiopia; Odendoet.al. (2010) examined the determinants of the speed of adoption of fertilizer, manure and composting in western Kenya; Pornpratansombat et.al. (2010) investigated the factors affecting the speed of organic rice farming adoption in Thailand; Sutthiporn P.and Orachos N. (2012) analyzed the diffusion pattern of hybrid maize varieties and determined the factors affecting the speed of adoption by maize farmer in Thailand, and the others.

2.6. Current status and research gaps on Technology adoption in Ethiopia

So far many empirical studies on agricultural technology adoption had conducted in the country by many researchers. Of these researchers few were (Itana, 1985; Getachew, 1993; Chilot 1994, Lelisa, 1998; Shiferaw and Holden, 1998; Kidane, 2001; Berhanu, 2002; Endrias, 2003; Dadi et.al, 2004; Habtemariam, 2004; Million and Belay, 2004; Workneh Abebe, 2007; Motuma, 2008; Hailu Beyene, 2008; Abebe, 2011).

In this section the researcher assesses adoption studies in Ethiopia and presents their methodological approaches used, important variables identified by the previous studies, and their drawbacks from the his point of view.

Starting from 1960s many institutions have been attempting to generate and distribute improved agricultural technologies to smallholder farmers in Ethiopia. Following this Adoption studies started in the mid 1970. Some of these studies were carried out in areas where integrated rural development projects had been undertaken following the introduction of integrated rural development pilot projects and minimum package programmes in some parts of the country (Tesfaye, 1975; Cohen, 1975; Bisrat 1980; Aragay, 1980).

These studies focused on evaluating the performance of the pilot projects and on examining the rate of adoption of technologies promoted by these projects. A study by Cohen (1975) did go beyond determining the rate of adoption and assessed the economic and social impacts of the new technologies in the Chilalo Agricultural Development Unit (CADU) area.

Research conducted in the 1980s and onwards in Ethiopia assessed the status of agricultural technology adoption using descriptive statistics and found out that the rate of adoption of improved varieties, fertilizer, herbicide, and other agronomic practices were low (Mulugeta et.al., 1992). According to Hailu et.al.(1992); Legesse et.al. (1992) and Legesse (1992) the amounts of fertilizer and herbicide applied by most Farmers in Ethiopia were below the recommended levels. The focus of some of the research conducted during this period is on the impact of centrally planned economic policies of the regime (i.e., State Farm formation, collectivization, resettlement, villagization, price control and inter-regional trade regulations) on the technology adoption process.

Adoption studies using econometric models normally carried out after the mid 1980s and these studies provided information on the use of improved inputs including seed, fertilizer, herbicides, extent of adoption and factors that affect adoption decisions of smallholder farmers in the country. Although these studies provided useful information on the rate of adoption and factors influencing adoption, the intensity of adoption was not adequately addressed. In general, the adoption studies had some limitations in their analyses and, thus, did not adequately explain farmers' adoption decisions (Hailu Beyene, 2008).

> *Most of the adoption studies conducted in Ethiopia used conventional static adoption models (e.g., Logit and Probit) for dichotomous dependent variables. In a few cases, the Tobit model was used to study farmers' extent and intensity of adoption of improved technologies. Moreover, some of these studies had methodological limitations (Aragay, 1980; Yohannes et.al, 1990), while others have data limitation (Bisrat, 1980). The study by Aragay (1980) had two methodological limitations. First, the study had used a linear regression model to analyze the adoption behaviour of farmers. This model determines the probability that an individual with a given set of attributes makes one choice rather than*

the alternative .Thus, the study did not include non-adopters in the analysis and therefore creates sample selection bias. Second, to identify factors affecting adoption the study drew conclusions from a correlation analysis, which does not control for the effect of other variables simultaneously(Hailu Beyene,2008).

Most empirical adoption studies in Ethiopia actually examined the relationship between observed explanatory variables and actual decisions made by individual decision makers in acceptance of a technology. However, the study by Yohannes et.al. (1990) used intended (planned) adoption for some of sample farmers as the dependent variable. This study considered those farmers who have expressed their intention to adopt the technology in the following years as adopters. It is often valuable to obtain farmers' opinions about the feasibility of using a technology and identify its merits and drawbacks though this information cannot be used to assess adoption decisions. The fact is that statements about what a farmer would like to door hopes to do are not substitutes for data on actual technology adoption (CIMMYT, 1993). Meaning those farmers who have a plan to adopt a technology may or may not adopt it, and therefore posed a methodological limitation on their study.

Using a two-step regression model, a study by Bisrat (1980) investigated pattern and determinants of fertilizer adoption in the Bako and Jima areas. In the first step, the study estimated the rate of adoption using a Logit model, then regressed rate of acceptance on a number of explanatory variables. The limitation of this study was that the number of observations for each study area was small (only four per area). As a result, the two parameters, (the intercept and slope or rate of adoption) were estimated with only two degrees of freedom.

Some of the studies were conducted more than three decades ago (Cohen, 1975; Tesfaye, 1975; Bisrat, 1980; Aragay, 1980) and since then, a number of changes have taken place in the structure of the rural economy of the country. For instance, the landlord-tenant relationship was abolished and extension strategy and policies related to rural development and rural organizational structures have been changed. As a result, the findings of these studies may not reflect critical factors underlying adoption patterns. Currently, there were also a few adoption studies after the economic reforms in the post-socialist system. Most of these reviewed studies used a component approach neglecting the fact that farmers often choose to adopt components of a technology package sequentially.

Surprisingly, none of the adoption studies in Ethiopia conducted study using duration analysis on compost technology adoption.

These indicate that there are still research gaps that should be addressed in order to explain farmers' adoption decisions adequately. For instance, adoption is a dynamic process, which results from learning about the new technology overtime. To better understand farmers' adoption decisions, one needs to particularly study farmers who have used the new technology over time. Although the dynamic process of adoption is recognized in the theoretical literature (O'Mara, 1971; Linder et.al., 1979), almost all the reviewed studies used cross-sectional data due to the scarcity of micro-level data over time. Thus, the studies have been unable to explore the dynamic nature of the process of adoption. However, studies by Besley and Case (1993b), Foster and Rosenzweig (1995) and Cameron (1999) used panel data and established the importance of learning in the adoption process. Information on the importance of learning, extent of adoption, impact of profit and risk, which are key factors in influencing farmers' adoption decisions over time are not available in Ethiopia and not adequate elsewhere. Moreover, all of these reviewed adoption studies had not examined the adoption of composting among farmers in Ethiopia.

This study, therefore, attempted to fill these gaps by providing evidence on the adoption of composting among Toke kutaye District farm households. A duration analysis using Cox proportional hazard model approach is employed to analyze the speed of adoption of the technology in the district.

Chapter Three

Data source and Methodology of the Study

3.1. The study area

West Shawa Zone is one of the 18 Zones in Oromiya Region, Ethiopia. It has 18 administrative districts (Toke-Kutaye, Ambo, Abuna-Gindeberet, Ada'a-Berga, Bako Tibe, Cheliya, Dano, Dandi, Ejere, Ilfata, Ginda-Beret, Jeldu, Jibat, Midakegn, Meta Robi, Nono, Tikur-Inchini, and Walmara) and 570 peasant associations with an estimated total population of 2.27 million in 2009. The zone covers an area of 14.9 thousand sq. km. The climate conditions of the zone can be classified as highland area (12%), midland area (54%) and lowland area (34%).

The study was carried out in Toke Kutaye district -one of the 18 districts of West shawa zone. The district separated from Ambo district in year 2005 holding 31 rural peasant associations and 4 urban '*kebeles*'. According to 2007 population data there were about 119, 989 population in the district of which 60,174 were males& 59,989 were females. The district shares boundary with different neighbor districts -Ambo district in East, Midakegn district in North, Xuqur -Inchini district in South & Chaliya district in West. Total area of the district is estimated to 788.87 $Km^{2.}$

Regarding weather condition the district has 27% Dega, 55% Woina dega, and 18% Desert. Gudar, Cholle (Kulba on its upper part), Indris and Kolba are among the known rivers while Teff, maize, wheat and barley are the major crops produced in there.

3.2.Data type, Data collection and sampling procedure

The study is conducted in Toke Kutaye District where no single previous research was undertaken on the current area of study. It was from this area that the primary data used for this study is obtained using structured questionnaire. In the identification of from whom the data would be collected the researcher used two stage sampling procedures. All of households from all agro-ecological zones (Dega, Woina-dega and kola) are included in the sample so that giving a valid general conclusion for the whole households living in these agro-ecological zones of the district will be possible. In order to ensure that all households within the population are fairly represented the researcher employed a simple random sampling as follows.

In the process of drawing sample households the researcher purposefully stratify a total of 31 peasant associations into three agro-ecological zones. As many areas in Ethiopia in general and Oromiya in particular has related agro-ecological zones, the researcher also prefers such stratification so that findings of the study can be easily replicated to the rest districts of the region without incurring further cost and waiting for a research for them, too.

After stratification into three agro-ecological zones is made, then households in each of the three agro-ecological zones were grouped as adopters and non-adopters of the technology based on the record obtained from the Supervisors of Agricultural Development Agent of different centers of the district.

Taking financial, accessibility and time constraints in to account at this level, 19 peasant associations were selected randomly. Regarding the sample size determination, Storck et.al.(1991) showed that the size of the sample depends on the available fund, time and other reasons not necessarily on total population. Hence, the researcher took a total sample size of 200 households of which 100 households are adopters and the rest are non-adopters of the technology from these 19 peasant associations using simple random sampling. Then, based on the number of populations living in each PA, the researcher draws a sample proportional to the number of adopters and non-adopters of the technology.

For the collection of these data in this way 8 enumerators from the local area who have at least diploma holders were trained well and sent for data collection. After data collection ended, the researcher randomly picked 2-5 respondents from each PA and checked whether the enumerators really collected an accurate data or not using a mobile number they provided on the questionnaire paper.

3.3. Methods of data analysis: Duration Analysis approach

In the investigation of the adoption of new agricultural technology many researchers have been employed cross-sectional data in a static approach to analyze why some farmers adopt at a given point in time(see Ayana, 1985; Mekuria, 1996; Yirga et al., 1996; Dadi et al., 2001;Marenya and Barrett, 2007; Motuma,2008 and the others).But adoption of agricultural technology should be considered as a continuous decision-making process(Sombatpanit, 1996): Individuals pass through various learning and experimenting stages from awareness of the problem and its potential solutions and finally deciding whether to adopt or reject the given technology. Adoption of new technology normally passes through four different stages, which include awareness, interest, evaluation, and finally adoption (Rogers and Shoemaker, 1971).

Each stages of the decision will have many constraints (social, economic, or physical) for different groups of farmers. Therefore, the static modeling framework approach to examine why some farmers adopt at a given point in time has several important drawbacks and leads policy makers to design a inappropriate policy based on the inappropriate policy recommendations made by the researchers (J.S. Butler and Christine M.,2010).

To begin with, the static approach ignores the timing of adoption (i.e. when is the right moment to adopt?). The approach focuses at a single point in time and tries to identify who is using the technology and who is not. But, technology adoption is a dynamic process. This means early adopters differ from later adopters and current non-adopters may eventually adopt the technology under consideration. The static approach, therefore, fails to consider the speed of adoption and the effect of time-dependent elements in elucidating adoption (Butler, J.S. and Moser, C., 2010).

The other limitation of the approach, according to (Butler, J.S. and Moser, C., 2010), is its inability to control for farmer heterogeneity even when panel data is available. we would lose some of our time-varying information in this approach, we would not be able to control for unobserved heterogeneity.

Duration models, on the other hand, have several advantages over these static models. They take advantage of more information, meaning the timing of adoption, which cannot be exploited in logit or probit models. Thus, they allow continuous-time analysis regardless of the periods used in the data themselves. This means that probabilities can be predicted over a period of one year regardless of the number of periods observed.

They also take into account the evolution of the adoption of the technology and its determinants over time. Moreover, duration analysis techniques are appropriate to account for right censoring [1](when we only know that the farmer did not adopt the technology at least up to a given period t), and easily handle time-varying covariates (Poolsawas, S. and Napasintuwong, O.A., 2012). These "right-censored observations contribute to the hazard rate with their survival information" (Coetzee, C., 2006).

Finally, duration models can be used to control for unmeasured heterogeneity (Deaton, 1997 and Butler, J.S. and Moser, C., 2010). Thus, a further advantage of hazard models is the ability to control for unmeasured heterogeneity without the need for a full panel data set. While this is not the same as controlling for farmer fixed effects, since, as described above, duration models can control for unmeasured differences in the pool of adopters and non-adopters over time, this is still an important improvement over standard cross-sectional approaches.

Recently, this model has been getting growing concern and applied in a number of agricultural economics studies to capture the dynamic aspects of technology adoption. Few of them were given below.

Fuglie and Kascak (2001) estimated the long-term trends in adoption and diffusion of conservation tillage by U.S. farmers; Burton et.al. (2003) explored the determinants of adoption of organic horticultural in the UK; Dadi et.al. (2004) estimated the impact of variables on the timing of agricultural technology adoption by smallholders in Ethiopia; Abdulai and Huffman (2005) explained the diffusion and farmer's adoption of crossbred-cow technologies in Tanzania; D'Emden et al. (2006) investigated significant variables on the soil-conserving adoption by grain farmers in Australia; Matuschke and Qaim (2008) studied the dynamics of hybrid pearl millet adoption in India; Hailu Beyene (2008) studied on Adoption of improved Tef and wheat production technologies in crop-livestock mixed systems in northern and western Shewa zones of Ethiopia; Odendo et.al. (2010) examined the determinants of the speed of adoption of fertilizer, manure and composting in western

[1]*A right censored subject's time terminates before the outcome of interest is observed. We see the entry date into a particular state, but we do not know its end date. Thus, if we observe entry at a particular time, say t_0, the only thing we are sure about the exit date' t' is that it is $t > t_0$ " (Trokie,M., 2009). Right censoring techniques allow subjects to contribute to the model until they are no longer able to contribute (end of the study, or withdrawal), or they have an event (Coetzee, C., 2006).Generally, the objective of survival analysis is to use all the information provided by the censored individual up until the time of censoring.*

Kenya; Pornpratansombat et.al. (2010) investigated the factors affecting the speed of organic rice farming adoption in Thailand; Sutthiporn P.and Orachos N. (2012) analyzed the diffusion pattern of hybrid maize varieties and determined the factors affecting the speed of adoption by maize farmer in Thailand, and the others.

Understanding these weaknesses of the discrete choice models listed above on one hand and the growing demand for duration models in recent years on the other hand, the researcher employed the Cox Proportional Hazard Model- which is quite important especially in the analysis of agricultural technology adoption such as composting.

3.3.1.Econometric specification of Duration Analysis for technology adoption: The Cox proportional Hazard model(CPHM)

The variable of interest in the analysis of duration data is the length of time that elapses from the beginning of some event either until its end (‘**failure’**)[2]or until the measurement is taken, which may precede termination (Greene, 2003:p.817).Similarly, to this study the timing of technology adoption, the start date would be set either at the time when the technology first available or the time of farmer’s entry if the farmer entered after the new technology was introduced. The end of a spell is the time when a farmer adopts the technology. In duration analysis, therefore ‘**T’** is a non-negative variable that represents the length of time farmers waited before adopting the technology.

For a given household, let ‘T’ denotes the time spent in the initial state (i.e. in non-adoption state) which is also known as **risk**[3] period of an event. A time at which the farmer household makes a transition from non-adoption to adoption state is termed as **‘failure’ time**. Since the cumulative distribution function is very useful in describing the probability distribution of a

[2]*An event (also called failure) is defined by some qualitative variable marking an end-point such as finding a job; the occurrence of death, divorce, etc. For example the ‘failure’ of job search will end in finding a job. Note: There are no negative connotations attached to this term.*

[3]*By definition, in order for an event to occur there has to be a preceding time period or duration in which the event did not occur. Additionally, an individual can only be eligible to experience an event if there was a period during which they were at ‘risk’ of experiencing the event e.g. in order for an individual to be at risk of getting divorced they have to be married. Note that the term risk simply refers to an individual’s ‘chance’ of experiencing an event and there are no negative connotations attached to this term.*

random variable, such as **time**, in survival analysis, the distribution of **T** is expressed by the following cumulative density function: F (t) = P (T ≤ t), where't' represents the cross-section of durations $t_1, t_2, \ldots, t_n$.

Observations in the model typically gathered from these cross-sections of durations. It demonstrates that the probability that duration time T is smaller or equal to some value't'**.**

In survival analysis it is more convenient to work with two related functions called the survivor function $S(t)$ and the hazard function $h(t)$. The survivor function is closely related to the cumulative distribution function. The survival function in the case of farmer waits before adoption is the probability of an individual not adopt until or beyond time t is defined as:

S (t) =1-F (t) = P ($T > t$)

Because of its relationship to the cumulative distribution function and the fact that T has a support set that is non-negative it immediately follows that any survivor function must satisfy $S(0) = 1$, $S(\infty) = 0$

The hazard function specifies the instantaneous rate of leaving per unit time period at **t** (Lancaster, 1990) or represent the probability that farmers adopt the new technology at time $t+\Delta t$. The hazard function for ***T***is defined as: $h(t) = \lim_{\Delta t \to 0} \frac{pr(t \le T < t+\Delta t | T \ge t)}{\Delta t}$

To estimate the hazard function and the effect of explanatory variables on the hazard, Cox Proportional hazard Model (CPHM)[4] (see Baltenweck, 2000 and Odendo et al, 2010) is employed.

The model is written as follows:

$$h(t, X) = h_0(t) exp\left(\sum_{i=1}^{p} X_i \beta_i\right)$$

Or equivalently, $log\ h(t, X) = log h_0(t) + \left(\sum_{i=1}^{p} X_i \beta_i\right)$

1. $\boldsymbol{h_0(t)}$-is considered as a starting or 'baseline' version of the model, prior to considering any of the 'X's. It only involves *time*,***t*****.**

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[4]*CPHM estimates the effects of explanatory variables on time until adoption while simultaneously adjusting for other possibly influential variables.*

2. $\boldsymbol{exp \sum_{i=1}^{p} \beta_i x_i}$-Contains the linear predictor and multiplies the baseline hazard. Notice that this term does not involve *t*. The assumption being made is that the individual predictors, x_i, are time-invariant.

3. $\boldsymbol{x_i}$ − is a vector of covariates or set of explanatory variables (see Table 1shown below) which accelerate or decelerate the adoption decision of the technology.

4. $\boldsymbol{\beta}$ −representsa vector of regression coefficients. Note that there is no intercept $\boldsymbol{\beta_0}$in the model since $h(t|x = 0) = h_0(t)$. That's why $h_0(t)$ is often called the baseline hazard function and is unspecified in the model. This makes the model a semi-parametric model.

3.3.2.Popularity of the CPHM in Duration Analysis

The Cox proportional hazard model has some peculiar features that make it so popular in recent days even among the class of survival data analysis models.

First, it can accommodate both fixed and time-varying variables and can control for unobserved heterogeneity. Therefore, they do not require panel data and only information on the timing of adoption is needed, but in doing so utilize more information than standard probit or logit model.

Second, because we model the log hazard as a linear predictor we are guaranteed that estimate of the hazard will be non-negative .We want such nonnegative estimates because, by definition, a hazard is always nonnegative.

Third, it is not necessary to actually specify the hazard function completely. The baseline hazard is not estimated in the Cox model because it drops out of the likelihood and is actually not needed when making comparisons of interest. All we need are estimates of the β's to assess the effect of explanatory variables of interest-not baseline hazard. This makes the model a semi-parametric model.

Fourth, unlike many of duration models which require the analyst to make arbitrary decisions about the functional form of the hazard, the Cox model does not assume a functional form for the baseline hazard rate as it is left unspecified in the statistical model.

Fifth,we would prefer to use a parametric duration models if we were sure of the correct model**.** When in doubt, the Cox model is a "safe" choice and the user does not need to worry about whether the wrong parametric model is chosen.

Finally, we can obtain the primary information desired from a survival analysis-a hazard ratio and a survival curve. It uses more information—the survival times—than the logistic model, which considers a (0, 1) outcome and ignores survival times and censoring.

The Cox model generally agrees with the correct parametric model when the survival times do follow a specific parametric form. Thus, the Cox model is robust to model misspecification.

"All models are wrong; some models are useful" ***(George Box)***

3.3.3.Hypothesis and definition of Variables of the model

The list of variables the researcher used is given in the following Table 1 with their expected sign.

Dependent variable (h(t))-Unlike discrete choice models, Duration analysis treats the length of time to adoption (or adoption spell) as the dependent variable. The dependent variable used in the analysis will be the time farmers waited before adopting compost, measured by the number of years elapsed since the introduction of the technology in the year 2008. For farmers who started farming as a household after the technology was introduced, the duration was counted from the year they started it to the year they adopted. For those farmers who had not as yet adopted, the duration was right-censored at the year of data collection.

Age in years of the chief of the household (chage) -A farmer's age can create or wear down confidence. Meaning, with age, a farmer can become more or less risk-averse to new technology. This variable can thus, expected to have a positive or negative effect on a farmer's decision to adopt the technology.

Education level (educ) –Education enables farmers to distinguish more easily technologies whose adoption provides an opportunity for net economic gain from those that do not (Rahm and Huffman, 1984; Abdulai and Huffman, 2005). Given that time to adoption is being modeled in this study, it is significant to note that more efficient adoption decisions could result in more educated farmers adopting the technology earlier.

Table 1 : Description of Variables in the empirical model and their expected sign

Variables	Definition and measurement	Exp.sign
h(t)	Length of time to adoption **(**or adoption **spell**[5]**)** -a dependent variable of the model.	
chage	Age in years of the chief household	±
educ	Education level of the household head: 1= secondary education and 0=below secondary education	+
fmsz	Farm size in hectares	+
ratioactoin	Ratio of economically active household members to inactive members	+
livesto	Livestock ownership in Tropical livestock unit(TLU)	+
indexaw*	Index of awareness -Extension services, participation in trainings and demonstrations	+
disth	Distance of the plot from the residential area in minutes	-
tenure	Whether a farmer perceives a risk of loss of land in the near future: 1=sure not to loss and 0=otherwise	-
wtrac	How the farmer perceived to water source accessibility in terms of distance walked :1=near to home 3 and 0= otherwise	-
vbadhlthpbm	Perception of farmers towards negative side effects of composting on their health : 1= very bad for health and 0=otherwise	-

**Index of awareness = (number of contacts with extension agents per year + visits to demonstrations + participation in training) divided by three.*

Farm size (fmsz)- Larger farm size is associated with greater wealth, increased availability of capital, and high risk bearing ability which makes investment in conservation more feasible (Norris and Batie, 1987). Moreover, farmers operating larger farms can afford to devote part of their fields sometimes the less productive parts to try out the improved

[5]*The time between successive events are referred to as 'spells'. Put simply, a spell is defined as the length of time that an individual spends in a particular state before transition to the other state. In case of this study spell refers to a transition from non-adoption to adoption of composting. The dependent variable will, therefore, be the duration (in years) defined from the time the farmer learnt about the technology to the time adoption took place.*

technology, and this may influence adoption (Rahm and Huffman, 1984). It is hypothesized that large farm size increases the probability of adoption of soil fertility enhancing technology-compost.

Ratio of economically active household members to inactive family members (ratioactoin) - Households with larger number of economically active labor are supposed to be better in undertaking different soil improving practices, since they are less likely to have shortage of labor which is required to do soil fertility improving activities including composting. Thus, all else equal, households with higher labor stock who contribute to **farm work** is hypothesized to increase the speed of the adoption of the technology because of the low opportunity cost of labour in the study area.

Livestock ownership (livesto) - Livestock wealth may provide animal excrement which is primary input for the preparation of compost. Therefore, livestock ownership is expected to speed up the likelihood of adopting the technology.

Index of Awareness (indexaw) - represents an attempt to capture the impact of extension services on the adoption behaviour of farmers. It may be expected that direct contacts between farmers and extension agents, visits to practical demonstration sites and visits to on-farm trials and research centers increase farmers' awareness of the new technologies and their performance. An information index was therefore created to capture the combined effect of such extension activities as follows:

Index of awareness = (number of contacts with extension agents per year + visits to demonstrations + participation in training) divided by three (Dadi et.al, 2004).

Distance from homestead (disth) -The average time the farmer must travel from the residential area to the plots has an effect on the status of soil conservation and rehabilitation practices. It is hypothesized that the further away the plots are from homestead the less effort employed in maintaining the soil fertility as transportation of the compost to the plot may be difficult (Pender, J. and Gebremedhin, 2010). In other words, the adoption of the technology is more on plots closer to residential areas and more attention is given to nearby plots (Alemu, 1999). So, we expect a negative relationship between adoption of the technology and a farmer's plot on a distant location from home.

Tenure (tenure)- According to Alemu (1999) if land ownership or user rights can be alienated from the holder at any point in time by forces outside his/her control and without the consent of the individual farmer, farmers will have little incentive to invest in technologies improving soil fertility.

Similarly, Cocchi et.al. (2005) found that landowners tend to adopt soil fertility improving technologies more frequently than tenants.
Thus, a **tenure** variable that measures the perceived risk of loss of land at some time in the future is hypothesized to negatively influence the adoption speed.

Accessibility to source of water (wtrac) - since water is one of the primary inputs for the preparation of compost, accessibility of this resource near to homestead will speed up the adoption of the technology.

Perception towards compost (vbadhlthpbm) - farmers' bad perception about the side effects of the compost preparation (eg: it causes anthrax) expected to retard its speed of adoption and hence this variable is expected to carry a negative sign.

Chapter Four

Results and Discussion

4.1. Introduction

This chapter presents the analysis and interpretation of survey data on 'Household level determinants of adoption speed of soil fertility boosting technology: A duration analysis approach of composting adoption in Toke kutaye district of West shawa, Oromiya'. The researcher organized the analysis of the study in to two parts: Descriptive analysis part and Econometrics analysis part. Both methods of analysis used primary data collected from a sample of 200 farm households living in the district.

4.2. Descriptive analysis of the sample data

This section summarizes survey data using tools descriptive statistics. The section starts with the summary of number of adopters and non-adopters with respect to survival times.

Table 2: Summary of adopters and non-adopters with respect to failure times

status		**Survival time (in years)**					**Total**
		1	**2**	**3**	**4**	**5**	
Adopters	frq	27	30	35	8	0	**100**
	r%	27.00	30.00	35.00	8.00	0.00	**100.00**
Non-adopters	frq	0	0	0	0	100	**100**
	r%	0.00	0.00	0.00	0.00	100.00	**100.00**
Total	frq	**27**	**30**	**35**	**8**	**100**	**200**
	r%	**13.50**	**15.00**	**17.50**	**4.00**	**50.00**	**100.00**

Source: Own survey, 2013 Key: frq=frequency r%=row percentage

The result of Table 2 above shows that of the total adopters of the technology(100 smallholder farm households), 27% failed one year after, 30% failed 2 years after, 35% failed 3 years, and 8% failed 4 years after the introduction of the technology in to the district.

Respondents reached secondary level of formal education are in a better position in adopting the technology than those respondents with educational level less than secondary. The data depicts that 53.33% of respondents with lower than secondary education recorded a longest failure time as compared to the secondary level of education attainment (34.29%)(Table 3).

Table 3: Educational level of the head of sample households

variable name			survival time (in years)					Total
			1	2	3	4	5	
Educational level of the Household head (1= if secondary level and 0= if below secondary level)	0	frq	21	23	26	7	88	**165**
		r%	12.73	13.94	15.76	4.24	53.33	**100.00**
	1	frq	6	7	9	1	12	**35**
		r%	17.14	20.00	25.71	2.86	34.29	**100.00**
	Total	frq	**27**	**30**	**35**	**8**	**100**	**200**
		r%	**13.50**	**15.00**	**17.50**	**4.00**	**50**	**100.00**

Source: own survey, 2013 Key: frq=frequency r%=row percentage

Similarly, in adopting the technology within a shortest period of time (i.e within one year) respondents with higher level of education (17.14%) outweigh those respondents with lower than this level (12.73%).This clearly shows that household heads with relatively better formal education are likely to foresee the productivity consequences of soil fertility boosting technology like compost.

Table 4: Distance between home and water source availability

variable name			Survival time (in years)					Total
			1	2	3	4	5	
Distance from water source(1= if near to homestead,0 =if far from homestead)	0	frq	10	18	14	7	62	**111**
		r%	9.01	16.22	12.61	6.31	55.86	**100.00**
	1	frq	17	12	21	1	38	**89**
		r%	19.10	13.48	23.60	1.12	42.70	**100.00**
	Total	frq	**27**	**30**	**35**	**8**	**100**	**200**
		r%	**13.50**	**15.00**	**17.50**	**4.00**	**50.00**	**100.00**

Source: own survey, 2013 Key: frq=frequency r%=row percentage

From Table 4 above, it was clear that 42.70% of respondents with access to water near to their home survived for 5 years. This figure is less than the percentage of respondents with access to water at a far away location (55.86%).In adopting within the short period of time, however, respondents living near to water source comprise the larger share (19.10% versus

9.015%).The implication is that households far away from water are discouraged to adopt the technology as water is one important input in the preparation of compost.

One can see that households with the perception that ‘their land could be taken away from them in the near future’ are found to be laggards (68.75%) in adopting the technology as compared to those with the perception of ‘no risk of loss with confidence’ (44.08%).As this laggards perceived, land is government owned and therefore they do not have a guarantee of risk of loss of their land in the future (Table 5).

The word of many respondents is that at any time if the government declared to take it away from us, we are not entitled the right to defend. Early adopters of the technology are those with secured perception of their land in the future and they act to boost the fertility of their farm land with this technology. These households comprised 15.13% as compared to 8.33% of households with insecurity feeling of their land. The message is that perception of land tenure security positively affects the speed with which farmers adopt long term soil fertility boosting technology like compost.

Table 5: Perception of sample households about their land tenure security in the future

variable name			survival time (in years)					Total
			1	2	3	4	5	
Perception of land tenure security(1= if secured perception 0= otherwise)	**0**	frq	4	8	2	1	33	**48**
		r%	8.33	16.67	4.17	2.08	68.75	**100.00**
	1	frq	23	22	33	7	67	**152**
		r%	15.13	14.47	21.71	4.61	44.08	**100.00**
	Total	frq	**27**	**30**	**35**	**8**	**100**	**200**
		r%	**13.50**	**15.00**	**17.50**	**4.00**	**50.00**	**100.00**

Source: own survey, 2013 Key: frq=frequency r%=row percentage

The descriptive result in Table6 below conveys that compost preparation is perceived to have a negative side effect on health status of the one who prepares it and hence, retarded its adoption speed. Traditionally compost preparation has seen as a dangerous activity as it assumed to born a life killing ‘worm’ called anthrax (known as ‘abbaa sangaa’ in local language).This traditional settings in the district is highly influencing farmers’ perceptions of compost adoption. Of the total respondents, 16.5% responded that compost preparation can cause very dangerous for health of the one who prepares it. Still respondents responded ‘no side effect of compost on health’ agreed that if care on when, where and how to prepare it is not taken it can cause a life threatening infection and therefore knowing the science of compost preparations is vital.

More than ever, the rumor of ‘anthrax’ has been spreading at high rate within the community and the researcher suspect that even those who adopt the technology may quit it in the near future. One rumor the researcher heard during the data collection is that compost killed a father and his son while they turn it. Many people then stopped making compost due this threat. Even those buried it never return back to it.

Table 6: Perception of households towards the negative side effect of compost making on health status

variable name			**Survival time (in years)**					**Total**
			1	2	3	4	5	
Perception of compost preparation on health status (1= if perceived to be very bad and 0= if perceived to be no side effect on health)	0	frq	26	25	32	8	76	**167**
		r%	15.57	14.97	19.16	4.79	45.51	**100.00**
	1	frq	1	5	3	0	24	**33**
		r%	3.03	15.15	9.09	0.00	72.73	**100.00**
	Total	frq	**27**	**30**	**35**	**8**	**100**	**200**
		r%	**13.50**	**5.00**	**17.50**	**4.00**	**50.00**	**100.00**

Source: own survey, 2013 Key: frq=frequency r%=row percentage

As can be seen from Table 7 below, as we move from the first age group to the second then to the third and so on, the percentage of respondents adopting the technology within 1 year (the highest speed relative to the rest survival times) increases.

The same sort of pattern is true when survival time is 2 years, 3 years and etc. This means younger farmers are more inclined to accept the technology than older ones due to the fact that old aged household heads may be more risk averse and less likely to accept technologies that are not time tested.

Table 7: Age of the chief household (in years)

variable name			survival time (in years)					Total
			1	2	3	4	5	
Age of a household head (in years)	20-35	frq	7	5	5	1	23	**41**
		r%	17.07	12.20	12.20	2.44	56.10	**100.00**
	36-50	frq	15	15	20	5	40	**95**
		r%	15.79	15.79	21.05	5.26	42.11	**100.00**
	51-65	frq	5	7	7	2	30	**51**
		r%	9.80	13.73	13.73	3.92	58.2	**100.00**
	>65	frq	0	3	3	0	7	**13**
		r%	0.00	23.08	23.08	0.00	53.85	**100.00**

Source: own survey, 2013

Key: frq=frequency r%=row percentage

The index of awareness (see Table 8 below) as measured by the ratio of the number of times the respondent took compost related training, seen field demonstration on compost and contacted by agricultural extension agent of the peasant association. The index measures how farmers can get information about better soil boosting technology in this case the compost. It was clearly seen in the table that as the level of this index increases the number of sample respondents failed in 1 year also increases.

Table 8: Index of awareness as measured by the ratio of the number of times the respondent took compost related training, field demonstration and contacted by DA

variable name			**Survival time (in years)**					**Total**
			1	2	3	4	5	
Index of awareness	<1.5	frq	10	13	12	2	62	**99**
		r%	10.10	13.13	12.12	2.02	62.63	**100.00**
	1.5<I<=3	frq	11	10	20	6	34	**81**
		r%	13.58	12.35	24.69	7.41	41.98	**100.00**
	3<I<=4.5	frq	5	5	3	0	4	**17**
		r%	29.41	29.41	17.65	0.00	23.53	**100.00**
	>4.5	frq	1	2	0	0	0	**3**
		r%	33.33	66.67	0.00	0.00	0.00	**100.00**

Source: own survey, 2013 Key: frq=frequency r%=row percentage I=Index of awareness

When the index level is less than 1.5, we find 10.10% of the respondents, when the index is in between 1.5 and 3(including), we find 13.58% of respondents and so on. In general, the index is highly influencing the rate of adoption of the technology in the district.

The variable farm size of the respondents is shown in Table 9 below. The size of the family farm is a factor that is often argued as important in affecting adoption decisions.

Table 9: Farm size of households (in hectares of land)

variable name			Survival time (in years)					Total
			1	2	3	4	5	
	frm<=2	frq	15	14	17	5	72	77
		r%	12.20	11.38	13.82	4.07	58.54	**100.00**
	2<frm<=4	frq	8	11	10	2	23	**54**
Farm size		r%	14.81	20.37	18.52	3.70	42.59	**100.00**
(in hectares)	4<frm<=7	frq	4	3	5	1	3	**16**
		r%	25.00	18.75	31.25	6.25	18.75	**100.00**
	frm>7	frq	0	2	3	0	2	**7**
		r%	0.00	28.57	42.86	0.00	28.57	**100.00**

Source: own survey, 2013 Key: frq=frequency r%=row percentage frm =farm size

It is frequently argued that farmers with larger farms are more likely to adopt an improved agricultural technologies compared with those with small farms as they can afford to devote part of their fields (sometimes the less productive parts) to try out the improved technology. The frequency and percentage result in the table supports this argument in many cases.

The ratio of number of economically active to inactive family members is still another variable worth analysis in the model. One of the key socio-economic factors that constrained the technology uptake across the district was high labour demand nature of the technology at the time of its preparation. Even farmers adopted the technology speak painfully of the labor requirement of the technology from its making stage to its transportation and final use for crop.

What one can observe from Table 10 below is that as the number of economically active family members increases, the number of late adopters (say at t=4) shows some sort of decreasing. When seen carefully it seems as if the higher number of economically active family members plays insignificant role.

Table 10: Ratio of economically active to inactive family members of the sample households

variable name			Survival time (in years)					Total
			1	2	3	4	5	
Ratio of number of economically active to inactive family members	Rt<1	frq	10	9	15	5	38	**77**
		r%	12.99	11.69	19.48	6.49	49.35	**100.00**
	Rt=1	frq	6	6	5	1	19	**37**
		r%	16.22	16.22	13.51	2.70	51.35	**100.00**
	1<Rt<=4	frq	10	11	13	2	36	**72**
		r%	13.89	15.28	18.06	2.78	50.00	**100.00**
	Rt>4	frq	1	4	2	0	7	**14**
		r%	7.14	28.57	14.29	0.00	50.00	**100.00**

Source: own survey, 2013 Key: frq=frequency r%=row percentage Rt=Ratio

Households' proximity to a farm plot from their home (in terms walking minutes) has a paramount contribution in lowering cost of transport and hence speeding up the adoption of the technology.

Table 11: Distance (walked in walking minutes) to the nearest plot from homestead

variable name			Survival time (in years)					Total
Distance walked to the nearest plot from homestead in minutes			**1**	**2**	**3**	**4**	**5**	
	d<=10	frq	16	23	24	6	57	126
		r%	12.70	18.25	19.05	4.76	45.24	**100.00**
	10<d<=25	frq	8	5	8	2	30	**53**
		r%	15.09	9.43	15.09	3.77	56.0	**100.00**
	25<d<=45	frq	2	2	3	0	12	**19**
		r%	10.53	10.53	15.79	0.00	63.6	**100.00**
	d>45	frq	1	0	0	0	1	**2**
		r%	50.00	0.00	0.00	0.00	50.00	**100.00**

Source: own survey, 2013 Key: frq=frequency r%=row percentage d=distance

This attributed to the fact that farmers give more attention to nearby plots (the nature of the compost technology actually did this) and the care given to distant plots is low. Therefore, the greater distance of a plot from homestead may have discouraged farmers from giving the necessary care and maintenance of the soil of their farm plot. The descriptive output in Table 11 shown above supports this argument. As distance interval increases the frequency of households failed in 1 year decreases. Similar decrease in the frequency of adopters observed when failure times are 2 years, 3 years, and 4 years.

Finally, number of livestock the respondents have (measured in Tropical Livestock Unit) has an effect on the adoption of the technology as animal excrement is considered to be a primary input of compost.

Table 12: Number of livestock the respondents have (in Tropical livestock unit)

variable name			**Survival time (in years)**					
Number of livestock the respondents have (in Tropical livestock unit)			**1**	**2**	**3**	**4**	**5**	**Total**
	T<=2	frq	3	5	5	0	34	47
		r%	6.38	10.64	10.64	0.00	72.34	**100.00**
	2<T<=4	frq	13	6	6	1	35	**61**
		r%	21.31	9.84	9.84	1.64	57.38	**100.00**
	4<T<=6	frq	5	4	10	5	16	**40**
		r%	12.50	10.00	25.00	12.50	40.00	**100.00**
	T>6	frq	6	15	14	2	15	**52**
		r%	11.54	28.85	26.92	3.85	28.85	**100.00**

Source: own survey, 2013 **Key**: frq=frequency r%=row percentage T=TLU

When the mean value and standard deviation (std.Dev) are computed for the non-categorical variables (Table13), the average mean time of failure for adopters of the technology found to be 2.24 years (i.e on average households waited for about 2 years before adopting the technology) with a standard deviation of 0.95.These two figures are less compared to the total sample households where the mean waiting time before the event of adoption occurs is about 4 years with standard deviation of 1.54.

Regarding the average value of the non-categorical independent variables (age of chief of household, livestock ownership, farm size, distance of nearest farm plot from homestead, index of awareness and ratio of economically active to inactive members of the family) adopters of the technology are in a better position compared to the non-adopter.

Table 13: Summary statistics for numeric value variables (for both adopters and non-adopters)

		Adopters		**No-adopters**		**Total sample**		
Variable	obs	mean	Std.Dev	mean	Std.Dev	obs	mean	Std.Dev
time	100	2.24	0.94	5	0	200	3.62	1.54
chage	100	45.49	11.57	45.17	11.95	200	45.33	11.74
livesto	100	6.40	4.95	3.58	3.35	200	4.99	4.45
fmsz	100	2.65	2.11	1.85	1.49	200	2.25	1.86
disth	100	10.72	9.99	14.64	11.91	200	12.68	11.14
indexaw	100	2.08	1.19	1.35	0.91	200	1.72	1.12
ratioactoin	100	1.76	1.78	1.66	1.45	200	1.71	1.62

Source: own survey, 2013

4.3. Results of Empirical model of the Cox proportional Hazard

Though the Cox proportional hazard model (CPHM) is a semi-parametric that is widely used among the hazard models, there is still an issue of proportionality which needs to be assessed before the model results can be safely applied. According to the proportionality assumption, the hazard ratio of two people is independent of time and it is valid only for time independent covariates. This means that the hazard functions for any two individuals at any point in time are proportional. In other words, if an individual has a risk of adoption at some initial time point that is twice as high as that of another individual, then at all later times the risk of adoption remains twice as high. This assumption of the model, therefore, should be tested in advance before the model results are put for conclusion and policy recommendation.

One method of testing the proportionality assumption is by using the Schoenfeld and scaled Schoenfeld residuals which must first be saved through the **stcox** command. In the **stphtest** command we test the proportionality of the model as a whole and by using the **detail** option we get a test of proportionality for each predictor. If the tests in the table are not significant then we cannot reject proportionality and we assume that we do not have a violation of the proportional assumption.

Accordingly, the researcher tested the assumption of the model and gets the result shown in Annex 1.

The output from '*stphtest*' shown in this annex is non-significant both globally and individually indicating an absence of evidence to contradict the proportionality assumption (see values under prob>ch (i)2) and, therefore, the sample data has a reasonable fit to the proportionality assumption of the Cox model. The model is also checked by including time interaction terms in the model (see Annex 2).

The other issue of concern in CPHM is the treatment of tied failure times. The proportional hazards model assumes that the hazard function is continuous and, thus, that there is no problem of tied failure times. Because of the way that time is recorded, however, tied events do occur in survival data. In such cases, the partial likelihood must be modified. Stata provides four methods for handling tied failures in calculating the Cox partial likelihood through the breslow, efron, exactm, and exactp options. If there are no ties in the data, the results are identical, regardless of the method selected. The result of the model shown under annex 9 to annex 12 confirmed that there is no problem of ties in the data as the same variables are insignificant or significant under all methods.

After checking these two issues in the model the researcher goes for regression of the Cox proportional hazard model to obtain estimates of the hazard ratio (ratio of hazard rates).To check whether the expected sign prior to running the regression is line with the result of the empirical model, Cox regression with coefficient result is done first. The result of this regression is given in Table 14.The result indicated that there is no deviation of the sign of all variables from their prior expected sign given in Table 1.

Table 14: Empirical output of Cox proportional Hazard model

t (time	Coefficient	Hazard ratio	p-value
Chage	-0.118	0.988	0.313
livesto	0.013	1.013	0.547
fmsz	0.114	1.121	0.058***
disth	-0.018	0.982	0.084***
indexaw	0.355	1.426	0.000*
educ	0.591	1.805	0.017**
near	0.242	1.273	0.250
sure	0.668	1.951	0.023**
vbadhlthpbm	-0.763	0.466	0.031**
ratioactoin	0.063	1.065	0.400

Source: own survey, 2013

* Significant at 1%, ** significant at 5% and *** significant at 10%.

Age of the chief of household (chage)

The coefficient of the variable ‘chage’ to mean age of chief of household is found to be negative but statistically insignificant. This is to mean that younger farmers are more inclined to accept the technology than older ones due to the fact that old aged household heads may be more risk averse and less likely to accept technologies that are not time tested.

In addition, with advance in age, the ability for the household head to participate in strenuous manual activities such as making of compost declines and this reduces the speed of the adoption of labour-intensive technologies.

Moreover, the result may indicate that older household heads probably have shorter planning horizons and are physically weaker, more resistant to change, and hence less interested in adopting soil fertility boosting technology like compost that have long-term effects.

This finding is in line to the findings of Teklewold, H and Kohlin (2011) who conducted a study on ‘Risk preferences as determinants of soil conservation decisions in Ethiopia’ and found older farmers as laggards in adopting soil conservation practices; Odendo, et.al.(2010)on adoption of soil fertility enhancing technologies in western Kenya’ and found as household heads grow older, their risk aversion increases and adapt less swiftly to a new phenomenon such as mineral fertilizer; Matuschke, I. and Qaim, M. (2008) on Hybrid Pearl Millet adoption in India and found negative coefficient of age of household head; Dadi,et.al.(2001) on adoption and Intensity of fertilizer and herbicide use in the Central Highlands of Ethiopia and found age of household has an indirect effect on fertilizer adoption on *Teff* and wheat; Million and Belay (2004) indicated that age had a weak and at the same time negative association with adoption, etc.

A number of other studies, however, have shown a positive relation of age of household head with adoption of a technology. For example, Adesina and Baidu-Forson(1995)'s study of the adoption of improved rice varieties in Burkinafaso and Guinea find age of chief household to relate positively to adoption, as do Comer et.al.(1999) in their study of sustainable practices in Tennessee. Still some other studies have shown no significant relation between adoption and age level of household head. Examples include Amponsah (1995)'s study of computers and information services in North Carolina, Baker (1992)'s study of computer adoption in New Mexico, and Caviglia and Kahn (2001)'s study of sustainable agricultural practices in Brazil.

Livestock ownership (livesto)

Ownership of livestock had the expected positive sign (suggesting more livestock ownership speeds up the adoption rate of compost) but statistically insignificant. This positive sign may be an indication that livestock wealth provides animal excrement which is primary input for the preparation of compost and thereby increases adoption speed of the technology. This finding is consistent with Marenya and Barret (2007) on adoption of manure in western Kenya; Odendo, et.al, (2010) on adoption of soil fertility enhancing technologies in western Kenya.

Farm size (fmsz)

As expected, farm size variable was found to be positively associated with speed of adoption and statistically significant. The positive coefficient of **fmsz** implies that farmers with relatively larger farm size had higher risk of compost. This can be attributed to the fact that fertility enhancement occupies part of the scarce productive land and, therefore, farmers with larger farm size can afford it compared to those with relatively lower farm size. This result is consistent with the findings of Okoye (1998) in Nigeria and Mbaga-Semgalawe (2000) in Tanzania. In Okoye's (1998) comparative analysis of factors in the adoption of traditional and recommended conservation practices in Nigeria, recommended soil erosion controlling practices adoption responded to farm size positively and significantly. That means, adoption tend to increase as farm size increases. Young and Shortle (1984) in USA also found similar result.

Distance of the nearest farm plot from homestead in walking minutes (disth)

Consistent with prior expectation, the coefficient of distance of a plot from homestead (**disth**) was found to be negative and statistically significant. This negative sign implies that farmers with plots that are far from residential area had lower relative risk of adopting soil fertility enhancing technologies that are labour-intensive. This can be attributed to the fact that farmers give more attention to nearby plots and the care given to distant plots is low. In addition, it may be too difficult to transport compost made around home to a distant farm plots.

Therefore, the greater distance of a plot from homestead may have discouraged farmers from giving the necessary care and maintenance for the plot. This result is in line with Alemu's (1999) findings in Oromia and Tigray of Ethiopia. He found that participation in soil conservation investment is negatively and significantly related to the physical distance of plots from the homestead. Another study conducted in northern Ethiopia also confirmed this result (Berhanu and Swinton, 2003). The descriptive result of the study also supports this finding.

Index of awareness (indexaw)

This variable is an indicator of access to information from three main sources: from agricultural development agent, participation in trainings and field demonstration on composting.

Contact with extension agents is expected to have a positive effect on adoption speed based upon the innovation-diffusion theory which postulates that innovation is communicated through certain channels over time among members of a social system and that access to information speeds up technology adoption.

Such contacts, by exposing farmers to availability of information can be expected to stimulate adoption. Participation in field days and demonstration and attending seminars has significant influence on perception and hence speed of adoption by farmers. As expected and in conformity to the descriptive analysis, access to training, field demonstration on composting and contact by agricultural extension for the purpose of the technology is positively associated with a speed of adoption of the technology and is highly significant.

Generally speaking this finding is a fascinating result as it corroborates *innovation-diffusion theory* of Rogers (1995).Specifically the finding corroborates the empirical findings many researchers. Kidane (2001) on adoption of new wheat and maize varieties in Tigray investigated that adoption of crop varieties were influenced by frequency of contact between the farmers and extension. The study also indicated that the higher contact time positively influenced the adoption decision of the farmers. The finding is also in line to the findings of Polson and Spencer(1991) in south western Nigeria on technology adoption process of cassava; Voh (1982) in Nigeria on adoption of recommended farm practice; Kebede et al. (1990) in Ethiopia on Adoption of new technologies in Ethiopian agriculture of Tegulet-Bulga District; Abdulai and Huffman (2005) who found that prior access to extension service accelerated the adoption of dairy cattle in Tanzania; Bezabih (2000), Nkonya et al. (1997) and Lelisa(1998).

Educational attainment (educ)

This variable enhances one's ability to receive, decode, and understand information. They go on and therefore an educated people make good innovators, so that education speeds the process of technological adoption.

As expected, education of the head of the household positively and significantly influenced the adoption speed of compost. The positive effect observed for education on adoption supports the *human capital theory* which states that innovative ability is closely related to educational level, farming experience, and information accumulation. More educated farmers are typically assumed to be better able to process information and search for appropriate technologies to alleviate their production constraints. The belief is that higher level of education gives farmers the ability to perceive, interpret and respond to new information much faster than their counterparts.

The result is consistent with the work of Fuglie and Kascak (2001) who observed that farmers with high school and college education adopted new technology more rapidly than farmers without a high school diploma; Studies of Hassen et.al. (1998) and Habtemariam (2004) also identified that farmers' education had positive and significant influence on adoption.

Distance of home from water accessibility (near)

Consistent with expectation, the coefficient of distance of a home from water source (**near**) was found to be positive but statistically insignificant. It implies that nearness of farmers to water source plays an important role in speeding up the adopting the technology as compared to those farmers far from water source. This finding is consistent with the descriptive result of the study.

Land tenure security (secure)

Consistent with prior expectation, this variable has a positive and statistically significant result. This implies that households having confidence on the current land policy so that they never face risk of loss in the future are more motivated to adopt the technology.

This result is supported by the *property right literature* that states secured land tenure gives incentives to farmers for applying and continue using land improving investments on their plots.

Specifically, the finding corroborates the descriptive result of the study which says early adopters of the technology are those with secured perception of their land in the future.

It is also supported with the empirical findings of Alemu (1999): if land ownership or user rights can be alienated from the holder at any point in time by forces outside his/her control and without the consent of the individual farmer, farmers will have little incentive to adopt technologies that improve soil fertility. Benin and Pender (2001) in their investigation of the incidence of land redistribution in the Amhara region of Ethiopia also found that tenure security is negatively affected by land redistribution which follows farmers' propensity to undertake land-improving investments including composting will deteriorate since they expect dispossession of their present holding through the event of future redistribution.

Perception of negative side effect of compost on health status (vbadhlthpbm)

In conformity to the prior expectation, the variable carries a negative sign and statistically significant. This negative sign may be due to the traditional settings exist in the society. Traditionally compost preparation has seen as a dangerous activity as it assumed to born a life killing worm which bites people called anthrax (known as '*abbaa sangaa'* in local language) as they call. This traditional setting in the district is highly influencing farmers' perception of compost adoption. Scientifically, however, the disease is caused by bacteria as against to the perception of these farmers. The hazard ratio of 0.4662 tells us those households with the perception that compost has a very bad health side effect have a 46.62% risk of retarding adoption speed of compost than their counterparts. The finding has no comparable empirical support as any of previous research takes this variable in to consideration.

Ratio of economically active to inactive family member (ratioactoin)

Available family labor -number of persons who can contribute for farm operation-is one of the important factors of production in peasant agriculture. Thus, labor issues seem to be of more concern in the decision to adopt this labor intensive technology.

In consistent with the prior expectation, the variable carried a positive sign but found to be statistically insignificant. The negative sign may have an implication of high labour demand of the technology. Thus, high adoption speed is more attractive to households with a large number of active labour forces than their counterparts .This finding is line to the descriptive result. Empirically also, the result confirmed the findings by Caviglia and Kahn (2001); Shiferaw and Holden (1998); Menale, et.al.(2009), and others.

Chapter Five

Conclusions and Recommendations

5.1. Conclusions

This paper presents the first attempt of using Duration analysis approach to determine the main factors affecting adoption speed of compost in Toke-kutaye district of west shawa zone, Oromiya. Among the class of Event-History (duration) models, Cox proportional Hazard model is employed due to the popular results of this model over other models like weibul model. Although the model has rarely been used in published studies of technology adoption; yet it has several advantages.

First, it can accommodate both fixed and time-varying variables and can control for unobserved heterogeneity. Therefore, they do not require panel data and only information on the timing of adoption is needed, but in doing so utilize more information than standard probit or logit model.

Second, because we model the log hazard as a linear predictor we are guaranteed that estimate of the hazard will be non-negative .We want such nonnegative estimates because, by definition, a hazard is always nonnegative.

Third, it is not necessary to actually specify the hazard function completely. The baseline hazard is not estimated in the Cox model because it drops out of the likelihood and is actually not needed when making comparisons of interest. All we need are estimates of the β's to assess the effect of explanatory variables of interest-not baseline hazard. This makes the model a semi-parametric model.

Fourth, unlike many of duration models which require the analyst to make arbitrary decisions about the functional form of the hazard, the Cox model does not assume a functional form for the baseline hazard rate as it is left unspecified in the statistical model.

Fifth, we would prefer to use a parametric duration models (i.e duration models other than CPHM) if we were sure of the correct model. When in doubt, the Cox model is a 'safe' choice and the user does not need to worry about whether the wrong parametric model is chosen.

Finally, we can obtain the primary information desired from a survival analysis-a hazard ratio and a survival curve. It uses more information—the survival times—than, for instance, the logistic model, which considers a (**0, 1**) outcome and ignores survival times and censoring.

The Cox model generally agrees with the correct parametric model when the survival times do follow a specific parametric form. Thus, the Cox model is *robust to model misspecification.* Let me quote to the word of George Box and pass to the next section:

"All models are wrong; some models are useful"   (George Box)

It was by using this popular model that data from a sample of 200 households were analyzed and a number of important results of high policy significance were revealed.

First, with each year increase in Age of the chief household, the risk of speeding an adopting of the technology decreases. This is to mean that younger farmers are more inclined to accept the technology than older ones due to the fact that old aged household heads may be more risk averse and less likely to accept technologies that are not time tested. In addition, with advance in age, the ability for the household head to participate in strenuous manual activities such as making of compost declines and this reduces the speed of the adoption of labour-intensive technologies. Moreover, the result may indicate that older household heads probably have shorter planning horizons and are physically weaker, more resistant to change, and hence less interested in adopting soil fertility boosting technology like compost that have long-term effects. However, this result is statistically insignificant.

Second, Number of livestock owned is found to move in the same direction with the speed of adoption of compost carrying a positive sign though statistically insignificant. The descriptive result also says that, on average, adopter of the technology have about twice (average=6.40) of livestock as compared to the non-adopters (average=3.58).This implies that households with large number of livestock will easily get one of the primary input for the preparation of compost-animal excrement.

Third, Farm size has a positive effect on adoption speed of compost which implies farmers with larger farm size can adopt it compared to those with relatively smaller farm size.

Fourth, distance of a farm plot from residential area negatively affected the adoption rate of the technology but statistically insignificant.

Fifth, interestingly, speed of adoption of the technology is highly correlated with Index of awareness and is highly significant even at 1% significance level and this corroborates innovation-diffusion theory of Rogers (1995) and empirical works of others.

Sixth, Education of the head of the household is found to be positively and significantly influenced the adoption speed of compost .This supports the human capital theory and empirical works of other researchers.

Seventh, short distance of residential area from water source is identified to affect adoption speed positively but statistically insignificant.

Eighth, Land tenure security has a positive and statistically significant result. The result of the study shows that early adopters of the technology are those with secured perception of their land in the future.

Ninth, Traditional settings made people fear compost preparation as it supposed to born a threat to life worm they call 'anthrax' which is, however, not supported by science. This rumor pushed back a number of potential adopters and highly retarded adoption speed of the technology.

Tenth, available family labor, meaning the number of individuals who can contribute for farm operation, is one of the important factors of production in peasant agriculture. The variable carried a positive sign (implying high adoption speed is more attractive to households with a large number of active labour forces than their counterparts) but found to be statistically insignificant.

5.2. Policy implication

Farm size has a positive effect on adoption speed of compost which implies farmers with larger farm size can adopt it compared to those with relatively smaller farm size.

Therefore, farmers with large Farm size could increase their production by using compost fertilizer. Even if small farmers account for most of the cultivated land and production in the country, the fact that Farm size had a positive impact on speed of compost adoption implies that policy makers should give attention to large farmers in designing this technological intervention in order to achieve the goal of higher production and productivity.

Distance of a farm plot from residential area negatively affected the adoption rate of the technology. Therefore, the target of intervention should consider this issue before losing too much energy on farmers having farm plots from a distant location.

Index of awareness is found to accelerate adoption rate of the technology and is highly significant implying the index plays a great role in popularizing technology in the district. Today everyone is found in competitive globalized world.

If the aim is to enhance soil fertility using compost technology the planning, designing and implementation process of soil conservation activities should provide frequent compost related training, ensure that agricultural development agents have a good knowledge of the science of the technology especially how to prepare it in a way that pose no risk for farmers and focus on field demonstration for farmers so that making farmers competent in this competitive globalized world will be possible. Above all, it is expected from the extension agents to work closely with farmers than any other times.

Education of the head of the household positively influenced the adoption speed of compost. Households with secondary level of education found to accelerate the adoption of the technology as compared to households with less than this level education attainment.

Hence, the provision of adult education started and now find on a very infant stage in the district should be encouraged to a higher level to encompass all farmers of the district.

Land tenure security result shows that early adopters of the technology are those with secured perception of their land in the future. Therefore, creating more awareness towards their land security may really increase the adoption speed of the technology. By this awareness it will be possible to bring laggards to at least late adopters' group.

Traditional settings made people fear compost preparation as it supposed to born a threat to life worm they call 'anthrax' which is, however, not supported by science. This rumor pushed back a number of potential adopters. The concerned body should actively work against this 'unverified rumor'.

Cautionary Tale

One should understand from the whole results of the study that new technology adoption is not automatic. In addition, once adopted, the technology must be properly used if agricultural productivity is to increase. Nevertheless, without close attention to the use and adoption of improved agricultural technologies, production growth is likely to slow and rural poverty is likely to remain rampant. Despite about a decade of effort, the number of households adopted the technology are too few as compared to the total farm households in the district. To increase the likelihood of adopting this technology by smallholder farmers, policy makers should put emphasis on overcoming factors that highly discouraged/retarded its adoption speed or should put emphasis on encouraging factors that accelerate its adoption.

References

Abdulai, A., and Huffman, W. E. (2005). The Diffusion of New Agricultural Technologies: The Case of Cross-bred Cow Technology in Tanzania. American Journal of Agricultural Economics, Vol. 87.

Abebaw Shimeles, Penporn Janekarnkij and Vute Wangwacharakul (2011). Analysis of Factors affecting adoption of Soil conservation measures among Rural Households of Gursum District, Ethiopia.

Adesina, A.A. and J. Baidu-Forson (1995). Farmers' Perceptions and Adoption of New Agricultural Technology: Evidence from Analysis in Burkina Faso and Guinea, West Africa. Journal of Agricultural Economics.

Alemu, T. (1999). Land Tenure and soil conservation: Evidence from Ethiopia. Goteborg University, Sweden.

Amponsah, W.A. (1995). Computer Adoption and Use of Information Services by North Carolina Commercial Farmers.Journal of Agriculture and Applied Economics.

Annily Kausiku Mustafa-Msukwa, Jeff Mutimba, Charles Masangano and Annily Kausiku(n.d).An assessment of the adoption of compost manure by Smallholder farmers in Balaka district, Malawi.

Aragay Waktola (1980). Assessment of the diffusion and adoption of agricultural technologies in Chilalo.Ethiopian Journal of Agricultural Science.

Assefa, A. (1995). Analysis of production efficiency and the use of modern technology in crop production: A study of smallholders in the Central Highlands of Ethiopia.Wissenschaftsverlag Vauk, Kiel, Germany.

Ayana, I. (1985). An Analysis of Factors Affecting the Adoption and Diffusion Patterns of Packages of Agricultural Technologies in Subsistence Agriculture: A Case Study in Two Extension Districts of Ethiopia. Addis Ababa University.

Baker, G.A. (1992).Computer Adoption and Use by New Mexico Nonfarm Agribusinesses.American Journal of Agricultural Economics.

Bekele, S., Holden, S.T. (1998). Resource degradation and adoption of land conservation technologies in the Ethiopian Highlands: A case study in Andit Tid, North Shewa.

Benin, S.and Pender, J. (2001). Impacts of land redistribution on land management and productivity in the Ethiopian Highlands.Socio-economic and Policy Research Working Paper 43.ILRI, Addis Ababa, Ethiopia.

Berhanu Bedasa (2002). Analysis of factors affecting the adoption of cross bred dairy cows in the central highlands of Ethiopia: The case of two districts in North Shawa zone. Unpublished M.Sc. Thesis, Haromaya University.

Berhanu, G. and Swinton, S.M. (2003). Investment in soil conservation in Northern Ethiopia: The role of land tenure and public programs. Journal of Agricultural Economics.

Besley, T., and A. Case (1993b). Taking learning seriously: A diffusion model for HYV cotton. Unpublished, Princeton University.

Besley, T., and A. Case. (1993a). Modeling technology adoption in developing countries.

Bezabih Emana (2000). The Role of New Varieties and Chemical Fertilizer under Risk: The Case of Smallholders in Eastern Oromia, Ethiopia. Ph.D. dissertation, University of Hannover, Germany.

Bisrat Aklilu (1980). The diffusion of fertilizer in Ethiopia: Pattern, determinants and implication. The Journal of Developing Areas.

Bonabana, J., (2002).Assessing Factors Affecting Adoption of Agricultural Technologies: The Case of Integrated Pest Management (IPM) in Kumi District of Eastern Uganda,Virginia.

Butler, J.S. and Moser, C. (2010).Complementarities and differences in adoption an application of hazard models to two technologies in Madagascar: Selected Paper prepared for presentation at the Agricultural & Applied Economics Association, Denver, Colorado.

Cameron, Lisa A. (1999). The importance of learning in the adoption of high- yielding variety seeds. American Journal of Agricultural Economics, 81: 83-94

Caviglia, J.L. and J.R. Kahn (2001). Diffusion of Sustainable Agriculture in the Brazilian Tropical Rain Forest: A Discrete Choice Analysis, *Economic Development and Cultural Change.*

CIMMYT (1993). The adoption of agricultural technology: A Guide for Survey Design, Mexico.

Cocchi, H., E. Bravo-Ureta, B., and Quiroga, R. (2005).Adoption of Conservation Technologies among Hillside Farmers in Honduras and El Salvador.

Coetzee, C. (2006). A Practical Guide to Survival Data Analysis for Panel Surveys Using Stata.University of Cape Town.

Cohen, J. (1975). Effects of Green Revolution Strategies on tenants and small-scale land owners in the Chilalo Region of Ethiopia.The Journal of Development Areas.

Comer, S., E. Ekanem, S. Muhammad, S.P. Singh, and F. Tegegne (1999). Sustainable and Conventional Farmers: A Comparison of Socio-Economic Characteristics, Attitudes, and Beliefs. Journal of Sustainable Agriculture.

CSA (1991).Agricultural sample survey report on area, production and yield of major crops by sector and season. Addis Ababa, Ethiopia.

D'Emden, F. H., Llewellyn, R. S. and Burton, M. P. (2006). Adoption of Conservation Tillage in Australian Cropping Regions: An Application of Duration Analysis. Technological Forecasting & Social Change.

Dadi, L., Burton, M. and Ozanne, A. (2001).Adoption and Intensity of Fertilizer and Herbicide Use in the Central Highlands of Ethiopia.

Dadi, L., Burton, M., and Ozanne, A. (2004).Duration Analysis of Technological Adoption in Ethiopian Agriculture. Journal of Agricultural Economics-Volume 55, Number 3, Nov. 2004.

Deaton, A. (1997).The Analysis of Household Surveys. Johns Hopkins University Press, Washington DC.

Dong, D. and Saha, A. (1998). He came, he saw, (and) he waited: An empirical analysis of inertia in technology adoption. Journal of Applied Economics.

Doss, C.R. (2003).Understanding Farm Level Technology Adoption: Lessons Learned from CIMMYT's Micro Surveys in Eastern Africa. CIMMYT Economics Working Paper 03-07, Mexico.

Endrias Geta, (2003). Adoption of Improved Sweet Potato Varieties in Boloso Sore Woreda, Southern Ethiopia. MSc. Thesis Presented to the School of Graduate Studies of Haromaya University.

Feder, G., E. R.Just and D. Zilberman (1985). Adoption of Agricultural Innovations in Developing Countries: A Survey of Economic Development and Cultural Change.

Foster, A.D., and M. R.Rosenzweig (1995). Learning by doing and learning from others: Human capital and technical change in agriculture. Journal of Political Economy, 103 (61).

Fuglie and Kascak (2001).Adoption and Diffusion of Natural-Resource-Conserving Agricultural Technology. Review of Agricultural Economics, Vol. 23

Getachew Olana (1993). Farmer's response to new coffee development technologies and factors influence it: The case of small farmers in Gimbi CIPA, Wollega. Unpublished MSc. Thesis submitted to Haromaya University.

Getnet Hunegnaw (2008). Evaluation of On-Farm Composting and Compost Quality at Ilala Gojo Welmera Woreda, Oromiya Region.Addis Ababa University.

Greene, W.H. (2003). Econometric Analysis, 5th ed., USA

Habtemariam Abate (2004). The comparative influence of intervening variables in the adoption behaviour of maize and dairy farmers in Shashamane and Bishoftu, Ethiopia. PhD Thesis, University of Pretoria.

Hailu Beyene (2008).Adoption of improved teff and wheat production technologies in crop-livestock mixed systems in northern and western Shewa zone of Ethiopia. University of Pretoria.

Hailu Beyene, Franzel, S., and W. Mwangi.(1992). Constraints to increasing wheat production in the smallholder sector.

Hassen Rashid, M. and Kiarie Njoroge (1998).Adoption and Performance of Improved Maize in Kenya: Maize Technology Development and Transfer, London.

Hossner, LR. and Juo, ASR. (1999). Soil Nutrient Management for Sustained Food crop Production in Upland Farming Systems in the Tropics. Juo Soil and Crop Sciences Department College Station Tennessee, USA.

Baltenweck and S.J. Staal (2000). Determinants of Adoption of Dairy Cattle Technology in the Kenyan Highlands: A Spatial and Dynamic Approach. Contributed Paper Submission IAAE Meetings, Berlin.

International Food Policy Research Institute (IFPRI), Wageningen University and Research Center (WUR), and Environmental Economics Policy Forum of Ethiopia (EEPFE) (2005).Poverty and Land Degradation in Ethiopia: How to Reverse the Spiral?

Itana Ayana (1985). An analysis of factors affecting the adoption and diffusion patterns of packages of agricultural technologies in subsistence agriculture.A case study in two extension districts of Ethiopia.Unpublished, MSc. Thesis, Haromaya University.

Janson, H. G. P. (1992). Inter-regional variation in the speed of modern cereal cultivars in India.Journal of Agricultural Economics.

Kaliba, A.R.M., Verkuijl, H., Mwangi, W., Byamungu, D.A., Anadajayasekeram, P., and. Moshi, A.J. (2000). Adoption of Maize Production Technologies in Intermediate and Lowlands of Tanzania.Journal of Agricultural Economic.

Keifer N.M. (1988).Economic Duration Data and hazard models.Journal of Economic literature, vol.26.

Kennedy, P. (1992). A guide to Econometrics, 3rd ed. The MIT Press, Cambridge.

Kidane Gebremariam (2001). Factor influencing the adoption of new wheat and maize varieties in Tigray, Ethiopia: The case of Hawzien woreda.Unpublished, MSc. Thesis, Haromaya University.

Kurbat, M.A., S.K. Shevell, and L.J. Rips.(1998). A year's memories: The calendar effect in autobiographical recall. Memory & cognition.

Lancaster, T. (1978).Econometric Methods for the Duration of Unemployment**.**Econometrica**,** Vol. 47.

Legesse Dadi (1992). Analysis of factors influencing adoption and the impact of wheat and maize technologies in Arsis Negelle, Ethiopia. MSc thesis, Haramaya University of Agriculture, Ethiopia.

Lelisa Chalchisa (1998). The Determinants of Adoption, Intensity and Profitability of Fertilizer use: the case of Ejere District, West Showa. MSc. Thesis, Addis Ababa University, Ethiopia.

Linder, R.K., A.J. Fischer and P. Pardey (1979).The time to adoption. Economic Letters.

Lulseged Tamene and Paul L. G. Vlek (2008**)**.Land use and soil Resources.

Madeleine Inckel, Peter de Smet, Tim Tersmette, Tom Veldkamp (2005). The preparation and use of compost. Digigrafi, Wageningen, The Netherlands.

Madlener and Schmid (2003). Adoption and diffusion of decentralized energy conversion technologies: The success of engine co-generation in Germany: Energy and environment.

Marenya, P., and Barrett, C.B. (2007). Household-level Determinants of Adoption of Improved Natural Resources Management Practices among Smallholder Farmers in Western Kenya, Food Policy.

Matuschke, I. and Qaim, M. (2008). Seed Market Privatization and Farmers' Access to Crop Technologies: The Case of Hybrid Pearl Millet Adoption in India. Journal of Agricultural Economics, Vol. 59, No. 3

Mbaga-semgalawe, Z. and Folmer, H. (2000). Household adoption behavior of improved soil conservation: The case of the North Pare and West Usambara Mountains of Tanzania. Land Use Policy.

McNamara, K.T., M.E. Wetzstein, and G.K. Douce (1991).Factors affecting Peanut Producer Adoption of Integrated Pest Management.Review of Agricultural Economics.

Mekuria, M. (1996). Technology Development and Transfer in Ethiopian Agriculture: empirical evidence. Proceedings of the Inaugural and First Annual Conference of the Agricultural Economics Society of Ethiopia, 8-9 June 1995, Addis Ababa, Ethiopia.

Menale Kassie, Precious Zikhali, Kebede Manjur, and Sue Edwards (2009). Adoption of Organic Farming Techniques: Evidence from a Semi-Arid Region of Ethiopia. Environment for Development.

Million Taddesse and Belay Kassa (2004). Factors influencing adoption of soil conservation measures in south Ethiopia: The case of Gununo area. Journal of Agriculture and Rural development in the Tropics and sub tropics.

Motuma Tura (2008). Explaining Disadoption of Agricultural Technologies: The Case of Improved Maize Seed in Central Western Ethiopia.Addis Ababa University.

Mulugeta Lemenih (2004). Effects of Land use Change on Soil Quality and Native Flora Degradation and Restoration in the Highlands of Ethiopia. Implication for Sustainable Land Management.Swedish University of Agricultural Science, Sweden.

Mulugeta Mekuria, S. Franzel, and Hailu Beyene (1992).Farming systems research in Ethiopia: Evolution, development and organization.

Nkonya, E.T. Schroeder, T. and Norman, D. (1997).Factors Affecting Adoption of Improved Maize seed and fertilizer in Northern Tanzania. Journal of Agricultural Economics

Odendo, Martins; Obare, Gideon and Salasya, Beatrice (2010). Determinants of the speed of adoption of soil fertility enhancing Technologies in western Kenya: Contributed Paper presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa.

Okoye, C. U. (1998). Comparative analysis of factors in the adoption of traditional and recommended soil erosion control practices in Nigeria, Soil and Tillage Research.

O'Mara, Gerald T. (1971). A decision theoretic view of the microeconomics of technique diffusion in a developing country. PhD dissertation, Stanford University.

Omotayo, O. E. and K. S. Chukwuka (2009).Soil fertility restoration techniques in sub-Saharan Africa using organic resources.African Journal of Agricultural Research, Vol. 4.

Oyetunji OI, Ekanakaye IJ, Osonubi O (2001). Influence of yam fungi on cassava-maize intercrop in an alley cropping system. 5th Proceedings of African Crop Science Conference, Uganda.

Pender, J. and Gebremedhin, B. (2010). Land Management, Crop Production, and Household Income in the Highlands of Tigray, Northern Ethiopia: An Econometric Analysis.

Peter Moon, P.E., (1997).Basic On-Farm Composting Manual, a final report Prepared forthe clean Washington center.

Polson, R. A. and D. S.C.Spencer (1991). The technology adoption process in subsistence Agriculture: The case of cassava in southern Nigeria.

Poolsawas, S and Napasintuwong, O.A. (2012) .A Duration Analysis of Hybrid Maize Adoption in Thailand. Paper prepared for presentation at the 1st National Conference on Agricultural Economics, Resource Economics, Food Economics and Agribusiness. May 18, 2012, Bangkok, Thailand.

Pornpratansombat, P., Bauer, B., and Boland, H. (2011).The Adoption of Organic Rice Farming in Northeastern Thailand.Journal of Organic Systems, Vol. 6, No.3.

Rogers EM, Shoemaker FF (1971).Communication of innovations. Free Press, New York.

Rogers, Everett. (1983). Diffusion of innovations. Free Press, New York.

Runquist, F. M. (1984). Hybrid maize diffusion in Kenya.Land University.

Shields, M. L. G., G.P. Rauniyar and F. M.j Goode (1993). A longitudinal analysis of factors influencing increased technology adoption in Swaziland, 1985-1991. The Journal of Development Areas, 27: 469-483.

Siddinqsons Agro and Food (n.d).Organic Farming: A new revolution is silently taking place in Agriculture Sector.

Smith, T., Smith, B. and Ryan, M.K.(n.d).Survival Analysis Using Cox Proportional Hazards Modeling for single and multiple Event Time Data. Naval Health Research Center, San Diego.

Sombatpanit S, Zobisch MA, Sanders DW, Cook MG (1996) .Soil conservation extension: From concept to adoption. Science Publishers, Inc, Enfield, New Hampshire.

Storck, H., Bezabih Emana, Berhanu Adenew, Borowieck, A., Shimelis W/Hawariat, (1991). Farming systems and farm management practices of small holders in the Hararge high lands.Farming systems and resource economics in the tropics, vol.11, Germany.

Tadesse Yohannes and Abdissa Gemeda (1996).Effects of Compost and NP Fertilizer on Yield of Maize and Pepper. In Proceedings of the Third Conference of Ethiopian Society of Soil Science, February 28-29, 1996, Addis Ababa, Ethiopia.

Teklewold, H and Kohlin (2011).Risk preferences as determinants of soil conservation decisions in Ethiopia.Journal of soil and water conservation society.

Tesfaye Tekle (1975). Application of multivariate probit analysis to adoption model of new agricultural practices. Ethiopian Journal of Development Research.

Thapa, S. (n.d).Adoption of improved seeds and inorganic fertilizers in Nepal. University of Trento.

Tiwari, K.R., Sitaula, B.K., Ingrid, L.P.N., and Paudel G.S. (2008).Determinants of Farmers' Adoption of Improved Soil Conservation Technology in a Middle Mountain Watershed of Central Nepal. Environmental Management.

Trokie, M., (2009).STATA: An Econometrician's Guide. McGill University, Canada.

Workneh Abebe(2007). Determinants of Adoption of Improved Box Hive in Atsbi Wemberta District of Eastern Zone, Tigray Region .MSc, Thesis, Haramaya University

Yirga, C., Shapiro, B.I. and Demeke, M. (1996).Factors Influencing Adoption of New Wheat Technologies in Wolmera and Addis Alem Areas of Ethiopia. Ethiopian Journal of Agricultural Economics.

Yohannes Kebede (1992). Risk behaviour and new agricultural technologies: The case of producer in the central highlands of Ethiopia. Quarterly Journal of International agriculture.

Yohnnes Kebede, Gunjat, K., and Coffin, G. (1990). Adoption of new technologies in Ethiopian Agriculture: The case of Tegulet-Bulga District, Shoa province. Agricultural Economics

Young, C. E., Shortle. J. S. (1984). Investments in soil conservation structures: The role of operator and operation characteristics, Agricultural Economics Research.

Annexes

Annex 1: Testing Proportionality assumption of CPHM

Test of proportional-hazards assumption

Time: Time

	rho	chi2	df	Prob>chi2
chage	0.15570	2.47	1	0.1161
livesto	0.13944	2.08	1	0.1494
fmsz	-0.07691	0.68	1	0.4091
disth	-0.14982	2.29	1	0.1300
indexaw	0.09448	0.86	1	0.3541
educ	0.03010	0.09	1	0.7626
near	-0.13682	2.04	1	0.1528
sure	0.13274	1.88	1	0.1699
vbadhlthpbm	-0.01250	0.02	1	0.9024
ratioactoin	-0.05679	0.31	1	0.5788
global test		11.86	10	0.2942

Annex 2: Testing Proportionality assumption using time interaction variables

```
Cox regression -- Breslow method for ties

No. of subjects =          200                    Number of obs   =        200
No. of failures =          100
Time at risk    =          724
                                                  LR chi2(14)     =      55.44
Log likelihood  =   -481.09237                    Prob > chi2     =     0.0000
```

_t	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
main						
chage	-.0464062	.0274765	-1.69	0.091	-.1002593	.0074468
livesto	-.0570474	.0541577	-1.05	0.292	-.1631946	.0490998
fmsz	.1038789	.0607411	1.71	0.087	-.0151716	.2229293
disth	-.0182958	.01047	-1.75	0.081	-.0388165	.0022249
indexaw	.1963493	.213324	0.92	0.357	-.2217581	.6144567
educ	.5841214	.2483708	2.35	0.019	.0973235	1.070919
near	.2176557	.213482	1.02	0.308	-.2007614	.6360728
sure	.6711008	.2938227	2.28	0.022	.0952189	1.246983
vbadhlthpbm	-.752253	.3556937	-2.11	0.034	-1.4494	-.0551061
ratioactoin	.1734804	.1953449	0.89	0.375	-.2093886	.5563494
tvc						
chage	.015623	.0113027	1.38	0.167	-.0065299	.0377758
livesto	.0316767	.020638	1.53	0.125	-.008773	.0721265
indexaw	.0753992	.0945725	0.80	0.425	-.1099595	.2607578
ratioactoin	-.043298	.0835214	-0.52	0.604	-.206997	.120401

Note: variables in tvc equation interacted with _t

The result shows that none of this time interacted variable is significant. This implies that none of them violates the proportionality assumption.

Annex 3: Regression output of CPHM in terms of coefficients

Cox regression -- Breslow method for ties

No. of subjects =	200	Number of obs =	200
No. of failures =	100		
Time at risk =	724		
		LR chi2(10) =	49.75
Log likelihood =	-483.93376	Prob > chi2 =	0.0000

_t	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
chage	-.0117966	.0116915	-1.01	0.313	-.0347115	.0111183
livesto	.0133662	.0221939	0.60	0.547	-.0301331	.0568655
fmsz	.1137962	.0601136	1.89	0.058	-.0040243	.2316166
disth	-.0180567	.0104521	-1.73	0.084	-.0385425	.0024291
indexaw	.3546907	.0864299	4.10	0.000	.1852913	.5240902
educ	.5904583	.2484204	2.38	0.017	.1035632	1.077353
near	.2416451	.2098673	1.15	0.250	-.1696873	.6529776
sure	.6681922	.2931503	2.28	0.023	.0936282	1.242756
vbadhlthpbm	-.7630775	.3545705	-2.15	0.031	-1.458023	-.0681322
ratioactoin	.0630448	.0748394	0.84	0.400	-.0836378	.2097274

Annex 4: Regression output of CPHM in terms of Hazard ratio

Cox regression -- Breslow method for ties

No. of subjects =	200	Number of obs =	200
No. of failures =	100		
Time at risk =	724		
		LR chi2(10) =	49.75
Log likelihood =	-483.93376	Prob > chi2 =	0.0000

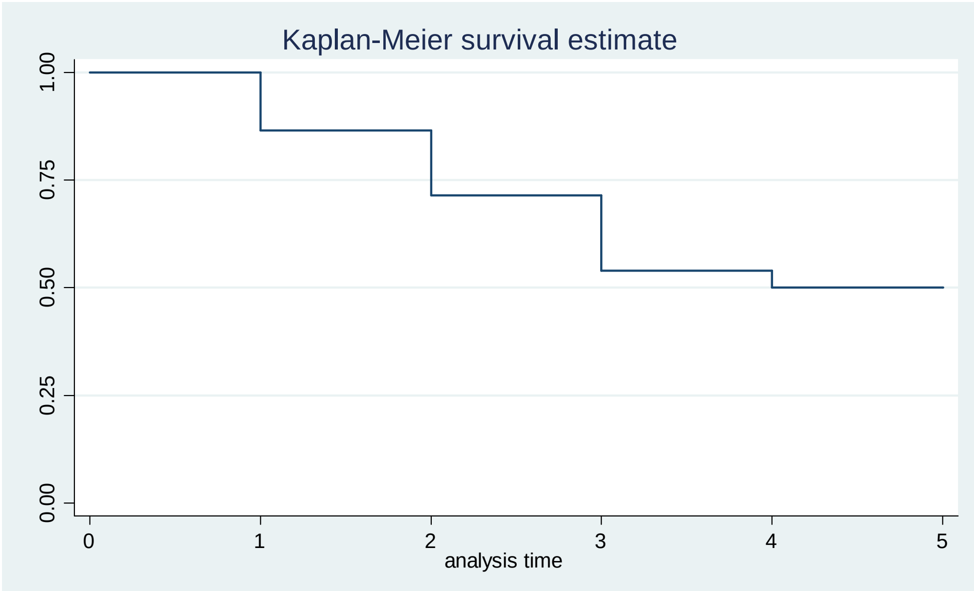
_t	Haz. Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
chage	.9882727	.0115544	-1.01	0.313	.9658841	1.01118
TLU	1.013456	.0224926	0.60	0.547	.9703164	1.058513
fmsz	1.120524	.0673587	1.89	0.058	.9959838	1.260636
disth	.9821053	.0102651	-1.73	0.084	.9621908	1.002432
indexaw	1.42574	.1232265	4.10	0.000	1.203569	1.688922
secondary	1.804815	.448353	2.38	0.017	1.109116	2.936896
near	1.273342	.267233	1.15	0.250	.8439287	1.921253
sure	1.950708	.5718504	2.28	0.023	1.098151	3.465151
vbadhlthpbm	.4662294	.1653112	-2.15	0.031	.2326959	.934137
ratioactoin	1.065075	.0797096	0.84	0.400	.9197643	1.233342

Annex 5: Incidence rate of adoption speed

	time at risk	incidence rate	no. of subjects	Survival time 25%	50%	75%
total	724	.1381215	200	2	4	.

There are 100 failures (adoption in this case), as the output from the stset command says. The ‘724’ refers to the total number of time periods for which this sample was observed at risk of adopting since time t= 0: the sum of timeacross all persons. The incidence rate of the model is0.1381215 = 100/724.The median survival time since the start of the study is **4** years.

Annex 6: Survival estimates from the data



Annex 7: Survival function

Time	Beg. Total	Fail	Net Lost	Survivor Function	Std. Error	[95% Conf.	Int.]
1	200	27	0	0.8650	0.0242	0.8093	0.9054
2	173	30	0	0.7150	0.0319	0.6470	0.7722
3	143	35	0	0.5400	0.0352	0.4684	0.6061
4	108	8	0	0.5000	0.0354	0.4289	0.5669
5	100	0	100	0.5000	0.0354	0.4289	0.5669

Annex 8: Probablity of variables to accelerate or decelerate adoption speed for a unit change in these variables

Variable name	Probablity*
chage	0.497
livesto	0.503
fmsz	0.528
disth	0.495
indexaw	0.588
educ	0.643
near	0.560
sure	0.661
vbadhlthpbm	0.318
ratioactoin	0.516

Note

***-**to mean the probability obtained is by converting the hazard ratio of the model .The conversion formula of hazard ratio to probability is given by

HR = P/ (1 − P) which implies

P = HR/ (1 + HR)where, HR=Hazard ratio P=probability

Annex 9: Checking the problem of tied failure times

Cox regression -- Breslow method for ties

```
No. of subjects =          200                    Number of obs   =        200
No. of failures =          100
Time at risk    =          724
                                                  LR chi2(10)     =      49.75
Log likelihood  =   -483.93376                    Prob > chi2     =     0.0000
```

_t	Haz. Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
chage	.9882727	.0115544	-1.01	0.313	.9658841	1.01118
TLU	1.013456	.0224926	0.60	0.547	.9703164	1.058513
fmsz	1.120524	.0673587	1.89	0.058	.9959838	1.260636
disth	.9821053	.0102651	-1.73	0.084	.9621908	1.002432
indexaw	1.42574	.1232265	4.10	0.000	1.203569	1.688922
secondary	1.804815	.448353	2.38	0.017	1.109116	2.936896
near	1.273342	.267233	1.15	0.250	.8439287	1.921253
sure	1.950708	.5718504	2.28	0.023	1.098151	3.465151
vbadhlthpbm	.4662294	.1653112	-2.15	0.031	.2326959	.934137
ratioactoin	1.065075	.0797096	0.84	0.400	.9197643	1.233342

Annex 10:Checking the problem of tied failure times

Cox regression -- Efron method for ties

```
No. of subjects =          200                    Number of obs   =        200
No. of failures =          100
Time at risk    =          724
                                                  LR chi2(10)     =      62.78
Log likelihood  =   -468.10448                    Prob > chi2     =     0.0000
```

_t	Haz. Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
chage	.986957	.0115375	-1.12	0.261	.9646009	1.009831
TLU	1.014646	.0225476	0.65	0.513	.9714023	1.059815
fmsz	1.144468	.0698628	2.21	0.027	1.015414	1.289925
disth	.9819997	.0102292	-1.74	0.081	.9621541	1.002255
indexaw	1.506327	.1314058	4.70	0.000	1.269591	1.787206
secondary	2.003182	.5021543	2.77	0.006	1.225583	3.274147
near	1.298471	.2749439	1.23	0.217	.8574231	1.966389
sure	2.184504	.646394	2.64	0.008	1.223158	3.901423
vbadhlthpbm	.4411192	.1561779	-2.31	0.021	.2203884	.8829239
ratioactoin	1.075354	.0805245	0.97	0.332	.9285646	1.245349

Annex 11: Checking the problem of tied failure times

Cox regression -- exact partial likelihood

```
No. of subjects =          200                    Number of obs   =        200
No. of failures =          100
Time at risk    =          724
                                                  LR chi2(10)     =      65.69
Log likelihood  =   -224.68963                    Prob > chi2     =     0.0000
```

_t	Haz. Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
chage	.9799113	.0133756	-1.49	0.137	.9540432	1.006481
TLU	1.029878	.0292189	1.04	0.299	.9741734	1.088768
fmsz	1.208506	.0927805	2.47	0.014	1.03968	1.404747
disth	.9766202	.0115714	-2.00	0.046	.954202	.9995651
indexaw	1.63749	.1741874	4.64	0.000	1.329329	2.017088
secondary	2.139871	.6385454	2.55	0.011	1.192301	3.840513
near	1.427582	.3503942	1.45	0.147	.8824236	2.309538
sure	2.339514	.7634911	2.60	0.009	1.234069	4.435187
vbadhlthpbm	.373632	.1442981	-2.55	0.011	.1752697	.7964918
ratioactoin	1.101755	.0975075	1.09	0.274	.926301	1.310443

Annex 12: Checking the problem of tied failure times

```
Cox regression -- exact marginal likelihood

No. of subjects =          200                     Number of obs   =       200
No. of failures =          100
Time at risk    =          724
                                                   LR chi2(10)     =     63.80
Log likelihood  =   -225.63519                     Prob > chi2     =    0.0000
```

_t	Haz. Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
chage	.9862552	.0116209	-1.17	0.240	.9637396	1.009297
TLU	1.016473	.0229781	0.72	0.470	.9724197	1.062522
fmsz	1.153051	.0721321	2.28	0.023	1.019998	1.30346
disth	.9819019	.0103048	-1.74	0.082	.9619112	1.002308
indexaw	1.521104	.1348239	4.73	0.000	1.278534	1.809696
secondary	2.024708	.515021	2.77	0.006	1.229827	3.333349
near	1.302815	.2786088	1.24	0.216	.8567459	1.981132
sure	2.206074	.6557001	2.66	0.008	1.232032	3.950194
vbadhlthpbm	.4371575	.1552327	-2.33	0.020	.2179616	.8767906
ratioactoin	1.078289	.0815301	1.00	0.319	.9297699	1.250533

Annex 13: Questionnaire

MEKELLE UNIVERSITY

COLLEGE OF BUSINESS & ECONOMICS

DEPARTMENT OF ECONOMICS

General Instruction

A. To the Respondents

Dear Respondents, I am **Robera Merga Bulti -**an Msc student in Economics at Mekelle University. As a precondition of obtaining my Msc degree, I have supposed to conduct a research entitled on '***Household level determinants of Adoption speed of soil Fertility boosting Technology: A duration analysis approach of composting adoption in Toke kutaye district***'. This questionnaire is, therefore, designed to collect information from you regarding the adoption of the technology beginning from its introduction into the district. Here are important points that you are expected to know while answering each and every questions:

- Apart from taking up your time, answering this questionnaire presents no risk whatsoever.
- All responses will be treated in strict confidentiality and will be used for academic research purposes only.
- Feel free to seek any clarification and ask any question regarding this research from the enumerator.
- Since your individual opinion is highly valuable, try to provide the correct answer for every question.
- The questionnaire should not take you more than about 15 minutes to answer the whole questions.
- There are no right or wrong answers; a quick response is generally the most useful
- If you think that important points related to the technology are not included here, please have a say.

B. TO THE ENUMERATOR

- Make it clear that you are a student/or collect for the student
- Try to create a friendly environment with them.
- Ask the respondents and wait them for ready cooperation before starting the questionnaire
- Impress on them the importance of the survey
- Don’t ask for information the researcher doesn’t require and irrelevance to this research
- Ask for approximates or estimates rather than exact answers—if the respondent has to leave
- Ensure that the questions have been understandable by the respondents.

YOU NEED NOT START UNTIL THEY ARE READY ENOUGH TO RESPOND!

1. GENERAL INFORMATION (1.1__1.10)

Farmers survey identification: _____________

Name of data collector: ___________________________________

Date of interview______________

Checked by: __________________

Date checked: _________________

1.1. Name of peasant Association/*kebele*________________________

1.2. Type of Agro-ecological zone of the peasant Association

Dega	Woina-dega	Kola
1	2	3

1.3. Name of the respondent ____

1.4. Own cell phone:_________________ or That of a neighbor:________________

1.5. Gender:

Male	Female
1	0

1.6. **Current** age________in years

1.7. Marital status**: (circle one)**

Single	Married	Divorced (separated)	Widow	If any other specify
1	2	3	4	

1.8. Social position in the peasant Association (PA)

PA council	PA manager	PA secretary	If any other specify
1	2	3	

1.9. Education level attended _______________grade(will be converted to categorical)

1.10. When the respondent did started farm formation as a **household head**?

Before 2008 (2000 E.C)	**After** 2008 (2000 E.C) in the year
1	

2. SOCIAL FACTORS

2.1. Household family members' and parents' information

S. No	Name of the families (Including parents)	sex	Age in years	Education level attended in years	Remark
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

3. ECONOMIC FACTORS

3.1. Do you have any other employment opportunity **in addition to farming**?

Yes	No
1	0

Only if your answer is 'Yes' do 3.1.1, otherwise proceed to question no 3.2

3.1.1. What type of employment opportunity is it? Elaborate it in relation to time and labor requirement, if so.

____

____

____

____

3.2. **Currently** how many of the following livestock do you have? (NB: Quantities registered will be converted to Tropical Livestock unit)

cows	Oxen	Bull	Calf	Heifer	Goat (A,Y)	Sheep (A,Y)	horse	Mule	poultry	donkey

3.2.1. At the time the government lifts fertilizer on credit basis just before 2 years in 2010 (2002 E.C), how many livestock did you have?

cows	Oxen	Bull	Calf	Heifer	Goat (A,Y)	Sheep (A,Y)	horse	Mule	poultry	donkey

3.2.2. At the time Ethiopia celebrates her millennium just in 2008, how many livestock did you have?

cows	Oxen	Bull	Calf	Heifer	Goat (A,Y)	Sheep (A,Y)	horse	Mule	poultry	donkey

3.2.3. At the time you adopt the technology, how many livestock did you have?

cows	Oxen	Bull	Calf	Heifer	Goat (A,Y)	Sheep (A,Y)	horse	Mule	poultry	donkey

A=Adult, Y=Young

4. PHYSICAL FACTORS

4.1. Currently, how many hectares of land do you have as shown in your **land use certificate?**

hectare

4.1.1. This current land size is also the **same size** since **2008 (2000 E.C)**?

Yes	No
1	0

4.1.2. Can you put your land holding size in terms of 'tsimad' ('oolchaa sangaa')?

Answer: ___________________________________

4.2. Which means of transportation did you use often to go to Guder town?

On foot	By Bus	By horse/mule
1	2	3

4.3. How long it takes you to reach the Guder town **on foot**?

hours	Minutes.

Please add additional points here, if any!

____

____

4.4. Have you started to use composting?

yes	No
1	0

If your answer is '**yes'** do **#4.4.1** to **4.4.3**, if '**No'** proceed to **4.6.**

4.4.1. In which year did you **start** to use it?

E.C

Please add additional points here, if any!

____

____

____

4.4.2. **Currently**, on what size of **farm plot** did you apply composting?

Answer: _________________ (in 'Tsimad' to mean '***Oolchaa sangaa'*** in local language)

4.4.2.1. Relative to the previous year, did this farm size under composting larger or smaller?

If smaller, why?

____

____

____

____.

If higher, why?

____

____

____

4.4.3. How do you think about beneficial aspect of composting **before adopting** it?

Unimportant at all	A little bit good	I don't know	Very important
1	2	3	4

Please add additional points here, if any!

____

____

____

4.5. What is the main source of material that you have used as an **input** for the preparation of compost?

Livestock's waste material	Crop residue	Leaf of a tree	Human waste material	Others
1	2	3	4	5

4.6. How long it takes you **on foot** from your home to the plot you have applied /could apply composting?

hrs	Min.

4.7. How do you feel your accessibility to water in your village in terms of **distance** you walk?

Very close	close	far	Very far
1	2	3	4

Please add additional points, if any on question **4.7.**

___

___

___

5. INSTITUTIONAL FACTORS

5.1. Whom do you think land belongs to?

My own	government	I am not sure
1	2	3

5.1.1. Do you expect that you will use the land throughout your life time?

I doubt	No, I may loss it	Yes, I am sure
1	2	3

5.1.2. Have you rented- in land at this moment?

Yes	No
1	0

5.1.2.1. If your answer is '**yes'**, who takes the **responsibility of keeping the land quality**?

Me	The owner	Both of us	None of us
1	2	3	4

5.2. Have you been participated in any training **related to composting**?

Yes	No
1	0

If your answer is '**YES**' do **5.2.1 to 5.2.3**, otherwise proceed to **5.3**

5.2.1. When and how many times did you participate?

Year	How many times in each year?
2012/2013	
2011	
2010	
2009	
2008	

5.2.2. What was the agenda of the training? *Possible to choose more than one answer!*

How to prepare composting	1
How to use composting	2
The importance of composting	3

5.2.3. So, how did you feel about the importance of the training?

Unimportant at all	A little bit good	I don't know	Very important
1	2	3	4

Can you explain the weakness and strength of the training?

____

____

____

Is there any government assigned ***agricultural Development Agent*** **(DA)** in your '*kebele*'?

Yes	No
1	0

If your answer is 'YES' do question 5.3.1 to 5.3.1.2, otherwise proceed to 5.4.

5.2.4. Did he/she inform you about the **existence of composting**?

Yes	No
1	0

If your answer is 'YES' do question 5.3.1.1 and 5.3.1.2, otherwise proceed to 5.4

5.2.4.1. What was his/her main contribution for you a as a DA on composting?

S/he tells us the importance of composting	1
S/he tells us how to prepare composting	2
S/he tells us how to use composting	3
S/he tells us from what it can be prepared	4
S/he has no contribution in all this cases	5

5.2.4.2. How many times he/she contacting/*contacted* you in a year on **composting** related issues before you adopt/*adopted* the composting technology?

Year	How many times in each year?
2012 (Sep.-Feb.)	
2011	
2010	
2009	
2008	

Please add additional points here, if any, regarding the strength and weakness of the DA?

____

____

____

5.3. Have you visited any field demonstration about composting?

Yes	No
1	0

5.3.1. If your answer for **# 5.4 above is 'Yes',** put how many times you visited it in the following table for each year if any.

Year	How many times in each year?
2012/2013	
2011	
2010	
2009	
2008	

Please add additional points here, if any!

____

6. ATTITUDINAL FACTORS

6.1. Do you think that composting preparation **harms the health status** of the one who prepares it?

Yes	No
1	0

6.1.1. If your answer for **# 6.1 above is 'Yes',** to what extent it is dangerous?

A little bit bad	bad	Very bad
1	2	3

6.1.1.1. What type of health problem it will cause?

____

____

____

Is there any one you may know that face the problem?

From whom you heard about the problem, if you are not a direct observer?

6.2. How would you see *the relative advantage of compost over synthetic fertilizer in terms of quantity requirement per hectare?*

Item	Very few quantity	few quantity	No difference	Large quantity	Very large quantity
Compost per hectare	**1**	**2**	**3**	**4**	**5**

Please add any additional point you have on question **# 6.2 above.**

6.3. To what extent **soil erosion** on your farm land is considered as a problem?

Not a problem at all	A little bit a problem	I do not know	Somehow a problem	A serious problem
1	**2**	**3**	**4**	**5**

6.3.1. In case you thought it **as a problem**, what do you think would be a solution?
Answer:

The End